COMPARATIVE EVALUATION OF TURMERIC PROCESSING METHODS AND STANDARDIZATION OF PROCESS TECHNOLOGY

M.Tech. (Agril. Engg.) Thesis

by

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COMPARATIVE EVALUATION OF TURMERIC PROCESSING METHODS AND STANDARDIZATION OF PROCESS TECHNOLOGY

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Phagu Ram Sahu

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CERTIFICATE - I

This is to certify that the thesis entitled "**Comparative evaluation of turmeric processing methods and standardization of process technology**" submitted in partial fulfillment of the requirements for the degree of **Master of Technology in Agricultural Engineering** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **Phagu Ram Sahu** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by him/her.

Chairman

Date: 08.01.16

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

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CERTIFICATE – II

This is to certify that the thesis entitled "**Comparative evaluation of turmeric processing methods and standardization of process technology**" submitted by **Phagu Ram Sahu** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur, in partial fulfillment of the requirements for the degree of **Master of Technology** in the Department of Agricultural Processing & Food Engineering has been approved by the external examiner and Student's Advisory Committee after oral examination.

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Place : Raipur

Date : 03/01/16

Phagu

(Phagu Ram Sahu)

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%	Per cent
&	And
°C	Degree Centigrade
Cm	Centimeter
avg.	Average
Anova	Analysis of variance
Atm	Atmosphere
Cd	Critical difference
Cv	Cofficient of variation
d.b.	Dry basis
Df	Degree of freedom
eq^n.	Equation
G	Gram
H	Hour
Hz	Hurtz
i.e.	That is
Kg	Kilogram
kg/h	Kilogram per hour
L	Liter
M	Meter
Mg	Milligram
min.	Minute
m/s	Meter per second
η_e	Field efficiency
m^2	Square meter
viz.	Namely
w.b.	Wet basis
wt.	Weight

LIST OF ABBREVIATIONS

Agri.	Agriculture
Agril. Engg.	Agricultural Engineering
BDMC	Bisdemethoxy curcumin
CCE	Column Chromatographic Extraction
C.G.	Chhattisgarh
CV	Coefficient of Variation
Dept.	Department
DMC	Demethoxy curcumin
Engg.	Engineering
et al.	et alibi
etc.	Etcetera
FAE	Faculty of Agricultural Engineering
Fig.	Figure
GI	Galvanize Iron
ICAR	Indian Council of Agricultural Research
IGKV	Indira Gandhi Krishi Vishwavidyalaya
MEKC	Micellar Electrokinetic capillary Chromatography
MR	Moisture Ratio
MS	Mild Steel
M.Tech	Master of Technology
NP	Nitrogen and Phosphorous
NPK	Nitrogen, Phosphorous and Potassium
P	Phosphorous
P_2O_5	Phosphorouspentaoxide
pH	Potential of Hydrogen
RH	Right Hand
RCBD	Randomized Complete Block Design
SD	Standard Deviation
SF	Synthetic Fertilizer
SVCAET	Swami Vivekanand College of Agricultural Engineering & Technology
UV	Ultra-Violet
USG	Urea Super Granular
TEAC	Trolox Equivalent anti oxidant capacity

THESIS ABSTRACT

a) Title of the Thesis: Comparative evaluation of turmeric processing methods and standardization of process technology

b) Full Name of the Student: Phagu Ram Sahu

c) Major Subject: Agriculture Processing and Food Engineering

d) Name and Address of the: Major Advisor
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Date: 08.01.16

Signature of Head of the Department

ABSTRACT

Turmeric (*Curcuma longa L.*), a member of the Zingiberaceae family, is one of the common spices used in Asian cuisine. In India the total production of turmeric is about 400,000 tones in fresh weight per year which was about 80% of the world's supply of commercial turmeric. Turmeric has been reported lots of medical properties and has been credited mainly due to the curcuminoids which are abundant in turmeric rhizome.

In the processing of turmeric different unit operations are conducted and out of that curing/boiling is the major unit operation. Also the processing methods

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are varying region by region. The common practice in Chhattisgarh is to boil the rhizomes in water/alkaline water/with cow dung prior to dehydration. This investigation deals with the study and documentation of traditional methods used in different parts of Chhattisgarh and its standardization with different pre-treatments i.e. boiling time (15, 30 & 45 min), sodium bicarbonate percent (0.05, 0.1 & 0.2), drying temperature (50, 60 & 70°C) on the basis of physico-chemical quality parameters. Also non-boiled samples with direct cut (1, 2 & cm) and non-boiled dried cut and treated with vacuum and drying.

During study total three traditional/commercial methods are document i.e. with use of cow dung and simple water during boiling of turmeric and some time they cut the turmeric into small pieces before drying. In the convective drying process it was observed that the drying time was reduced with the increased in the air temperature from 50 to 70°C. Also the complete drying takes place in falling rate period and no constant rate period was observed. The moisture diffusivity value ranges from 3.22×10^{-10} to 4.12×10^{-10} m^2/sec for the convective dried samples. In quality parameters, all samples have water activity value lower than 0.65 i.e. a good shelf life. In case of curcumin and oleoresin content the values are reduced with the increase in drying air temperature.

In time reduction technology non-boiled cut sample (1, 2 & 3 cm) drying time was reduced with the increase in drying air temperature and reduction in sample thickness i.e. from 3 to 1 cm and same was observed in case of vacuum treated sample.

शोध प्रबंध

शोध प्रबंध का शीर्षक	:	हल्दी प्रसंस्करण विधि का तुल्नातमक मुल्यांकन और प्रक्रिया प्रौद्योगिकी का मानवीकरण
छात्र का पूरा नाम	:	फागू राम साहू
प्रमुख विषय	:	कृषि प्रसंस्करण एवं खाद्य अभियांत्रिकी विभाग
मुख्य सलाहकार का नाम व पता	:	डॉ. एस. पटेल, विभागाध्यक्ष एवं व्याख्याता कृषि प्रसंस्करण एवं खाद्य अभियांत्रिकी विभाग एस.वी.सी.ए.ई.टी एवं आर.एस., एफ.ए.ई., इंदिरा गांधी कृषि विश्वविद्यालय, रायपुर (छ.ग.)
सम्मानित की जाने वाली उपाधि	:	प्रौद्योगिकी में स्नातकोत्तर (कृषि प्रसंस्करण एवं खाद्य अभियांत्रिकी)

प्रमुख सलाहकार के हस्ताक्षर

छात्र के हस्ताक्षर

दिनॉक: 08.01.16

विभागाध्यक्ष के हस्ताक्षर

सारांश

हल्दी (*Curcuma longa* L.), जिंजीबेरेसि परिवार के एक प्रमुख प्रजाति है, जिसका उपयोग एशि"ायाईं व्यंजनों में मसालें के रूप में प्रमुख रूप से किया जाता है। भारत में हल्दी का कुल उत्पादन लगभग 4,00,000 टन है साथ ही साथ विदे"ाी बाजारो में हल्दी का निर्यात में योगदान प्रति वर्श लगभग 80 प्रति"ात है। हल्दी में चिकित्सा गुण प्रचुर मात्रा

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में पाया जाता है इसका प्रमुख कारण है कुरकूमिंडोइस का हल्दी प्रकंद में मुख्य रूप से पाये जाना।

हल्दी के प्रसंस्करण में हल्दी का उबालना प्रमुख रूप से एक इकाईं उपचार है। क्षेत्रानुसार यह उपचार पध्दति विभिन्न प्रकार की होती है। छत्तीसगढ में आम तौर पर हल्दी प्रकंद को गाय के गोबर के साथ/पानी/क्षारीय पानी में उबालने के बाद निर्जलीकरण किया जाता है। शोध से यह पाया गया कि छत्तीसगढ के विभिन्न भागों में अलग अलग प्रकार का इकाई उपचार हल्इी प्रकंद का किया जाता है, उसमें से प्रमुख रूप से सम्मिलित है, हल्दी प्रकंद को क्रमशः उबालने का समय, (15, 30 और 45 मिनट), साथ ही साथ सोडियम बाइकार्बोनेट का योग प्रतिशत (0.05, 0.1 और 0.2) और सुखाने का तापमान भौतिक रासायनिक गुणवत्ता के आधार पर (50, 60 और 70 डिग्री सेल्सियस) है। बिना उबला हुआ कटौती नमूने (1, 2 व 3 सेमी) तथा बिना उबला हुआ नमूने को वैक्यूम ओवन के साथ उपचार किया गया।

इसी प्रकार शोध के दौरान कुल तीन वाणिज्यिक/पारंपरिक तरीकों का उपयोग करते हुए हल्दी प्रकंद को क्रमशः गाय के गोबर को मिलाकर साधारण पानी में उबाला गया तथा सूखाने से पहले विभिन्न छोटे टुकडों में हल्दी प्रकंद को काटा गया। इस प्रक्रिया में यह पाया गया कि तापमान में 50 से 70 डिग्री सेल्सियस वृध्दि के साथ सुखाने के समय में कमी पायी गयी। इस प्रेक्षण से पूरे प्रक्रिया में सुखाने की दर में लगातार कमी पाया गया। संवहनी सुखाईं यंत्र में जल प्रसरण गुणांक का मान $3.22X10^{-10}$ से $4.12X10–^{10}$ मी^{2} प्रति सेंकण्ड के बीच पाया गया। गुणवत्ता के मानकों कें, सभी नमूनों में पानी की गतिविधि 0.65 के रूप में सुरक्षित पाया गया। इस स्थिति में सुखाने के तापमान में वृध्दि के साथ कुरकुमिन और ओल्योरिसिन के मूल्यों में कमी पायी गयी।

प्रक्षेण में पाया गया कि हल्दी प्रकंद के बिना उबले कटौती नमूना (1, 2 व 3 सेमी) को सुखाने समय 1 से 3 सेमी नमूना मोटाईं में जैसे जैसे हवा के तापमान में वृध्दि करने पर उसके सुखने के दर में कमी पायी गयी इसी प्रकार का परिणाम निर्वात उपचार के नमूना में भी पाया गया।

CHAPTER-I

INTRODUCTION

Turmeric (*Curcuma longa* L.) is one of the essential elements of the Indian recipes. Besides the taste and aroma, it is also being used for medicinal value since ancient times. It was popular even in Vedic times because of its unique flavour and medicinal properties and its significance in religious ceremonies and auspicious occasions (Jacob, 1995). Turmeric is a spice derived from the rhizomes of *Curcuma longa*, which is a member of the ginger family Zingiberaceae. The root or rhizome has a tough brown skin and bright orange flesh. Fresh rootstock has an aromatic and spicy fragrance, which on drying generates a peculiar medicinal aroma. The bright yellow colour of turmeric comes mainly from polyphenolic pigment curcuminoids (Aggarwal *et al*., 2007).

Its centre or origin is believed to be South-East Asia and a few species are naturalized in north-eastern regions of India. India is believed to be the home of turmeric contributing the largest share in production, consumption and export in the world. It accounts for 80 per cent of the world output and 60 per cent of world export. Indian turmeric is considered to be the best in the world market because of its high curcumin content. The important turmeric growing States in India are Andhra Pradesh, Tamil Nadu, Orissa, Maharashtra, Assam, Kerala, Karnataka, West Bengal and Rajasthan. Andhra Pradesh occupies 61 per cent of total turmeric area followed by Tamil Nadu and Orissa with 17 per cent and 7 per cent area respectively. India has 0.65 Lakh hectare area under turmeric cultivation with a total production of 4.48 lakh tonnes during 2010-11 (Spice Board of India). Other major producers of turmeric are China, Myanmar, Nigeria, Bangladesh, Pakistan, Sri lanka, Taiwan, Burma and Indonesia *etc*.

In Chhattisgarh, turmeric is an important cash crop grown by tribal families for their livelihood and more than 50% of these crop growers are of tribal family. Chhattisgarh contributes about 11.80% of India’s turmeric cultivation in terms of area. The total turmeric production in Chhattisgarh is about 83470 Mt from 9747 ha. (Annual report of horticulture, 2013-14). In the state of Chhattisgarh, Korba, Jagdalpur, Sarguja, Jashpur, Kondagaon, Balod, Surajpur and Balrampur are some of the major turmeric producing district. Also in the tribal area crop is grown in the backyard with their indigenous methods of crop production.

Turmeric is mainly used as a spice in Indian foods and has medicinal value also (Peter 1999). The rhizomes of the this plant, when dried and ground, provide a yellow and flavoring powder, used for centuries as a natural coloring agent in food, cosmetics and textiles, and also as insect repellent. Recently, it has been valued worldwide as a functional food, due to its health promoting properties. Turmeric has been used as antioxidant, digestive, anti-microbial, anti-inflammatory and anti-carcinogenic agent. It lowers total cholesterol levels. It is also efficient in the treatment of circulatory problems, liver diseases, and dermatological disorders and in blood purification.

The curcumin present in the turmeric inhibit skin cancer by decreasing the expression of proto-oncogenes. External application relieves pain and swelling, heals wounds and treats many skin diseases ranging from acne to leprosy. Turmeric supports the heart by inhibiting the accumulation of platelets which reduce the chance of heart attack or stroke. It is used as blood purifier and supports the respiratory system as an anti-oxidant to protect lungs from pollution and toxins. The major chronic disease including atherosclerosis, cancer, cardiovascular diseases, cataracts, and rheumatoid arthritis are relieved with anti-oxidants like Vitamin C, Vitamin E and Turmeric.

The increasing demand for natural product as food additive makes turmeric an ideal natural food colorant. Additionally, anti-cancer and antiviral activities of turmeric may also increase its demand from pharmaceutical industries (anonymous 2008). United Arab Emirates (UAE) is the major importer of turmeric from India i.e. nearly 18% of total export followed by United States of America (USA) with 11%. The other importers are Bangaldesh, Japan, Srilanka, UK, Malaysia, South Africa, Netherland and Saudi Arabia. All these countries together account 75% of world trade and Asian countries supply to the entire world. Remaining 25% is met by Europian and central and latin American counties (anonymous 2008)

Turmeric has very good nutritive and medicinal values. Turmeric contains protein (6.3 per cent), fat (5.1 per cent), minerals (3.5 per cent), carbohydrates

(63.0 per cent), fibre (6.1 per cent), moisture (13.1 per cent), calcium (0.02 per cent), phosphorus (0.26 per cent), iron (0.05 per cent), sodium (0.01 per cent) and potassium (2.5 per cent). Vitamins presents in turmeric are B_1 (0.09 mg/100 g), B_2 (0.19 mg/100 g), vitamin C (49.8 mg/100 g) and niacin (4.8 mg/100 g). Turmeric contains up to 5 per cent essential oils and 3 per cent curcumin, a polyphenol (Ganpati *et al.* 2011).

The post harvest processing of turmeric involves many units operations such as washing, cleaning, curing or blanching, drying, polishing, size reduction and packaging. Harvested turmeric is washed thoroughly to remove the adhering soil, hairs and roots. The fingers and mothers rhizomes are separated prior to curing. Curing is the process of boiling the raw rhizome in water for the development of attractive colour and characteristic aroma which also destroys the viability of the fresh rhizomes, eliminates the raw odour and reduces the time of drying. Generally curing/boiling is done in alkaline water; also there was some recommendation as per the quality of boiling water. If the water is acidic; 0.05 to 0.1% sodium bicarbonate or carbonate is sometimes added to make it slightly alkaline. Boiling in alkaline water is said to improve the colour of dried powder with orange yellow colour (Pruthi, 1976; Govindarajan, 1980; Velappan *et al*., 1993; Weiss, 2002, Krishnamurthy *et al*., 1975).

Pruthi (1993), Jose and Joy (2005) reported that traditional drying method could result in the loss of atile oil (up to 25 per cent) by evaporation and in the destruction of some light sensitive oil constituents. The traditional drying methods are risky and result in mold growth, loss of some atile oil affect its smell by through evaporation and destruction of some heat sensitive pungent properties. A quick dehydration that yields a higher quality product is always required. Convective drying is the simplest and most economic method for dehydration of foods could be a good solution (Jayaraman and Das Gupta, 1992; Krokida and Marinos-Kouris, 2003). However, there are controversies with respect to the importance of cooking the rhizomes in water or alkaline solution prior to drying and its influence on the levels of curcuminoid pigments and on the colour of ground turmeric. Therefore, study is necessary to investigate the role of different processing steps on the quality of ground turmeric. Also the other important aspect would be the technology/method capable of improving the stability of curuminoid pigments. Thus by considering the above point, study was undertaken to standardization the process technology for conversion of farm fresh turmeric rhizomes into powder with the following specific objectives:

1. To study and document the different traditional practices used for turmeric processing in the state of Chhattisgarh.
2. Comparative evaluation of different pretreatments (adopted in common practices) used in turmeric processing and standardization of the suitable method.
3. To work on economic and time reduction technology for conversion of farm fresh turmeric rhizomes directly into dry concentrate.
4. To study the different quality parameters (physical & biochemical) of turmeric powder.

CHAPTER-II

REVIEW OF LITERATURE

In this chapter, the previous work done on the processing methods of turmeric rhizome, the effect of different pre-treatments and temperature on the drying characteristics and evaluation of quality of the dried product are briefly enumerated.

The review of literature is divided into the following sub divisions.

2.1 Curing process of rhizome.

2.2 Drying methods of rhizome.

2.3 Quality of the final product.

2.1 Curing Process

Hass *et al.* (1974) reported that blanching improves the rehydration characteristics of carrots with incorporation of certain additives.

Begum and Brewer (2001) studied the physical, chemical and sensory qualities of snow peas blanched with boiling water and steam. The effect of different methods of blanching on the L, a, b values of the colour of various vegetables were studied. No difference occurred in lightness L values. Boiling water-blanched peas were the least green, with low ‘a’ values, whereas steam blanched peas were the most green. Boiling water-blanched peas had the low ‘b’ value whereas there was no significant difference in ‘b’ values for steam blanched sample.

Suresh *et al.* (2005) studied the heat treatments of turmeric, red pepper and black pepper by: (i) boiling for 10 min, (ii) boiling for 20 min and (iii) pressure cooking for 10 min. It was observed that the significant loss of active constituent of spices was subjected to heat processing. Curcumin loss due to heat processing inturmeric was 12.1-18.8 mg/g, with maximum loss in pressure cooking for 10 min.

Blasco *et al.* (2006) studied the blanching effect on turmeric drying. The drying kinetics was carried out with blanched and un-blanched rhizomes at different temperatures (60, 70, 80, 90 and 100ºC). One diffusion model and two empirical models (Weibull and Peleg) were used to describe mass transfer during drying. Blanching prior to drying accelerated the process rate at all test temperatures, although its effect was reduced when the air drying temperature increased.

Kamble and Soni (2009) conducted study to improve the traditional turmeric boiling pot and reduce the losses in quality, time and fuel in turmeric processing. Turmeric boiled in improved boiling pot retained 3.33% essential oils and 2.30% curcumin as against 2.93% and 2.57% respectively in traditional boiling pot. Also it was observed that turmeric rhizomes boiled for 35minutes in improved pot gave uniform colour than rhizomes boiled for 25 and 45 minutes.

Shinde *et al.* (2011) studied the treatments during processing of turmeric by traditional and steam blanching methods. It was observed that in the steam cooking process, fuel requirement was less than half of the traditional method. The loss of color observed in curcumin was 1.5 to 2.5 per cent in steam cooking, whereas in boiling; it was 1.6 to 3.5 per cent.

Lokhande *et al.* (2013) studied the effect of curing and drying methods on the recovery of curcumin content and essential oil content in different turmeric cultivars. The *Krishna* cultivars were best among the three cultivars on the basis of physico-chemical analysis whereas, *Salem* and *Tekurpeta* had higher values for colour. The fingers cured with improved method loose moisture at faster rate than uncured and cured with traditional method. The fingers of *Salem* cultivar cured with improved method followed by shade-net drying had got higher recovery. The essential oil content of three cultivars was unaffected by the curing and drying methods.

Patil and Chhapkhane (2013) studied the large scale of turmeric boiling by the use of conventional plants with multiple cooker and boiler assembly placed on trolley. The plant is provided with furnace, condensate extraction mechanism, packed pressure vessels and mobile plant. Here in boiling, the turmeric rhizomes are placed in the cooker and the steam is supplied from the boiler to the pressure cooker and the turmeric is boiled. In traditional plants the boiling is done without maintaining the pressure in the vessel, so the boiling is inefficient. The efficiency of the actual processing plant is 13.19% which is very less. This is due to the lot of losses from every part of plant. The losses are very hard to control in minimum cost. So the objectives of this project are to reduce cooking time, fuel consumption, heat losses, reduce labor effort and cost, recycle condensate.

Cheryl and Sylvia (2014) evaluations were conducted on the basis of whether or not there were any potential effects of blanching, harvest time, and location of growth on the quantity and quality of turmeric oleoresins. The highest antioxidant activity of 92.86% was obtained from turmeric rhizomes grown in the parish of Hanover while the highest turmeric oleoresin yields of 14.87% were obtained from the 15 minute blanched-treated turmeric rhizomes. With a new analog-selective RP-HPLC method, the curcumin, DMC, and BDMC were qualified and quantified. It was found that the highest yield of curcumin content of 22.69% was obtained from the 15 minute ‘blanched’ samples grown in the parish of Hanover from the 1st harvest period of the study. An analytical method validation with linear equations and correlation of regressions of R2=0.9991, R2=0.999.3, R2=0.9998 and R2=0.9992 for inter-day precision analyses were performed to validate the HPLC method.

Pratik and Shrikant(2015) study the different cooking processes of turmeric rhizome cooking after harvesting. the impact of cooking method used for curing the turmeric on the quality of final product given in this paper. Effect are made to find the best economical, time saving and less labor cost turmeric cooking method for turmeric. Significance of different method for curcumin, oleoresin and essential oil contents studied in this paper.

2.2 Drying Methods

Drying is one of the most important methods of preservation and production of wide varieties of products, was major aim to prolong its storage life. Unfortunately, changes in the physical and biochemical structure are inevitable because the fruits are treated with thermal, chemical and other treatments (Ratti and Mujumdar, 1996).

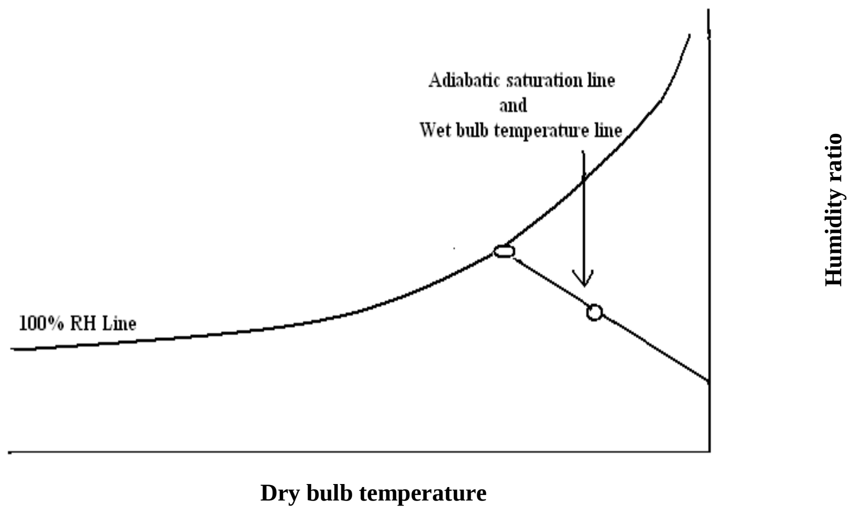

Fig. 2.1 Representation of adiabatic saturation in the psychometric chart (Barbosa- Canovas and Vega-Mercado, 1996)

The techniques of dehydration are probably the oldest method of food preservation applied by mankind. The difference between dehydration and drying is that drying is the removal of moisture from the material with phase change, whereas in dehydration (e.g. osmotic dehydration) water mostly stays in liquid form. (no phase change)

Theoretical concepts of drying deal with air-water mixture properties which consist of moisture content, wet bulb and dry bulb temperature and adiabatic saturation. The concept of adiabatic saturation line is summarized in Fig. 2.1. It shows no change in the wet bulb temperature but increases relative humidity due to the absorption of moisture from a drying product.

Generally, mechanism of drying inve two simultaneous processes, transfer of energy and mass. Energy transfer can be conductive, convective, radioactive or any combination of these three. Mass transfer includes the removal of moisture that moves from the interior of the dried material toward the surface under the capillary forces, liquid diffusion due to concentration gradients, surface diffusion and water vapour diffusion in pores filled with air, flow due to pressure gradient as driving force and flow owing to a vaporisation-condensation system (Barbosa-Canovas and Vega-Mercado, 1996).

The complete drying process can be divided in three stages. In the first stage of drying only free moisture at the surface is removed so the drying rate is constant. This is called the "constant rate drying period". At the end of this period, dry spots appear on the surface of the material and the drying rate decreases. This is the beginning of the "first falling rate period" (Fig. 2.2). Once the surface is completely dried, moisture is transported from inside of the product to the surface by capillary action. The third drying period is called "the second falling rate" and the drying rate is lower than the previous one (Mujumdar and Menon, 1995).

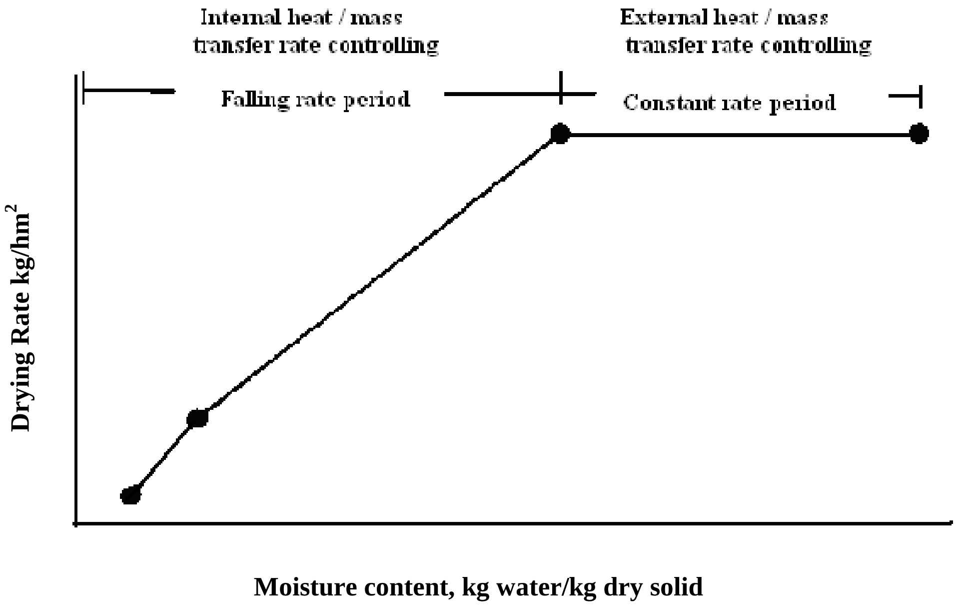

Fig. 2.2 Typical drying rate curves under constant- drying conditions
(Adapted from Mujumdar and Sirikalaya, 2000)

Several types of dryers and drying methods have to be developed and adopted for fruits with specific situation and commercial application. These dryers can be divided, considering many factors, such as pressure (atmospheric and sub atmospheric), type of unit operation (continuous, batch and semi continuous), the temperature (freeze drying and hot air convective drying) etc. Several dryers have been developed for drying fruits by using different techniques given (Somogyi and Luh, 1986; Jayaraman and Das Gupta, 1992) as follows:

i) Sun drying (open sun drying floor).
ii) Atmospheric drying
   a) Stationary or batch process (kiln, tower and cabinet dryer).

b) Continuous processes (tunnel, continuous belt, belt trough, fluidised bed, explosion puffing, foam mat, spray, drum and microwave- heated dryer.

iii) Sub atmospheric drying (vacuum shelf, vacuum drum and freeze dryer).

The main advantages in drying of fruits and vegetable are as follows (Somogyi and Luh, 1986).

i) Enhanced shelf life is high because of inhibition of microbial and enzymatic reaction.
ii) Substantially lower costs of handling, transportation and storage.
iii) Minerals and calorie providing constituents remain practically unaffected
iv) Provides consistent product as seasonal variations are diminished.
v) Dried fruits are packed in recyclable packages; but not always done with fresh fruits.
vi) They can be used in snack products and other processed food.

The main problems in fruit drying are damage to sensory characteristics and loss of nutritional components due to long exposure to high temperature (Van Arsdel, 1973; Fellows, 1988). These include loss of aroma, atiles, oxidation of pigments and vitamins and case-hardening in certain products.

Pruthi *et al.* (1959) suggested that, in order to secure large capacity and minimum operating costs of drying ginger, it was essential to use highest temperature that will not materially injure the product. It was also indicated that the optimum drying temperature and the critical temperature of the final product varied with the nature of the product and its moisture content.

Richardson (1966) carried out research on ginger dehydration in Australia. He concluded that 57 3°C was the highest temperature at which ginger can be dried for spice market and for extraction purposes the temperature up to 83°C can be used.

Ginzberg and Riezczikow (1969) described drying of onion slices of 3 mm thick in a vibrotluidized bed with additional infrared heating with an air temperature of 85- 90°C and an amplitude and frequency of vibration of 10 mm and 10-12.5 Hz, respectively. It was concluded that the onion reached 7 per cent moisture content after 90 min of drying.

Natarajan *et al.* (1972) reported that most part of drying of ginger in rotary dryer was controlled by moisture diffusion and was not hastened by agitation. They expressed that there was no justification for the extra power consumption in working the rotary dryer for long periods.

Ramanathan and Rao (1974) recommended the suitable drying temperature of ginger in the range of 60 to 70°C to get a better quality product and the drying time of about 5 to 9 hours depending on the method of drying.

Mazza and LeMaguer (1980) studied dehydration of 1.5 mm onion slices in Vibro Fluidizer. It has been suggested that heat and mass transfer processes at the surface of the product controlled the first period of drying and the second phase of drying was totally controlled by internal resistance.

Jimenez *et al.* (1984) conducted experiments on drying of onion slices of 4 mm thick at an air temperature of 70, 80 and 90°C and found two phases: a phase of approximately constant drying rate and a period of falling drying rate.

Sutar (1986) investigated the effect of drying air temperature on drying characteristics of ginger and its quality over a temperature range of 40 to 70°C. Based on the organolcptic quality and atile oil content of the dried product, an air temperature of 60 to 70°C was found suitable for ginger drying. The drying rate curves indicated that ginger drying process did not have a constant rate period and that in falling rate period ginger behaved like hygroscopic non-porous solid.

Carera-Rabi *et al.* (1987) reported that the best results in drying of onion are obtained with an air temperature 75°C in the beginning and decreasing it to 65°C after 2 hours.

Sawhney *et al.*(1993) developed an experimental through dryer with continuous weighing system for determining the drying rate constants for thin layer drying of onion. They examined the drying characteristics of onion by using ambient heated air temperature range of 50 to 80°C and an air flow velocity range of 0.25 to 1.0 m/s.

Michalik and Bakowski (1994) tested the suitability to drying of 9 varieties of onions grown in Poland. It was reported that the drying of 3 mm thick slices in a laboratory dryer at initial air temperature 65°C and reducing the temperature to 40°C after 2 to 3 hours of drying and continuing the process until 9 per cent moisture content was obtained in the final product.

Rapusas and Drisccoll (1995) studied thin layer drying characteristics of white onion slices. It was found that drying rate depended on drying'temperature, relative humidity, air velocity and material thickness.

Soponronnarit *et al.* (1995) investigated a strategy for chopped spring onion in a batch-wise flat bed. It was suggested that drying of chopped onion should be divided into three stages. In the first stage, drying air temperature was 80°C, specific air flow rate was 0.56 in7s-kg dry solid and drying time was 30 minutes. Drying air temperature and drying time were kept constant during second stage but specific airflow rate was decreased to 0.22 m'Ymin- kg dry solid. In the final stage, drying air temperature was decreased to 67°C and the specific air flow rate was decreased to 0.11 nrYs-kg dry solid and the drying time was approximately 102 min.

Kalra *et al.* (1996) tested five varieties of white onion for their suitability for dehydration. It was concluded, that the onion slices of thickness 3.5 to 5 mm dried in cross flow at a temperature of 55 to 69°C took 6 to 7 hours of drying time to reach a final moisture content of 5 to 7 per cent.

Martinez (1999) studied the drying process of garlic and grapes employing different sets of drying conditions. He used drying air temperature ranging from 40 to 60°C with a tray load density of 6 to 20 kg/m2 and an air velocity of 1 to 5 m/s with pre treatments before drying. It was observed that the effect of pre treatment namely, immersion of garlic in water and in sodium metabisulphite aqueous solution reduced the drying time by 25 per cent.

Pruthi *et al.* (1959) conducted a comparative study on four mechanical methods of dehydration of garlic. The methods included hot air drying by cross flow or by through flow separately, freeze-drying and vacuum drying versus sun drying. Based on the atile reducing substances, colour and flavour of garlic they recommended through flow dehydration was best suited for garlic to get good quality.

Pruthi (1970) conducted experiments on hand peeled and abrasive peeled ginger with and without lime treatment and dried under sun. It was found that satisfactory products were obtained in 7 to 9 days with final moisture content of 7.8 to 8.8 per cent.

Raina *et al.* (1978) investigated the performance of cross flow dryer to dry peeled, sliced ginger. It was found that the dryer took only 5 to 6 hours for peeled and sliced ginger as compared to 16 to 18 hours for drying of peeled whole ginger.

Mantri and Agrawal (1986) developed a multistage dehydration process for ginger and investigated the effect of process parameters such as pre treatments and drying of unpeeled ginger on the quality of the dehydrated product. They observed that the multistage dehydration process reduced the drying time of single stage process and the quality of the dried product was improved or at least maintained. They suggested that ginger may be dried at 85°C up to a moisture content of 50 per cent (wb) during first stage and may be dried at 65°C up to a moisture content of 12 per cent (wb) for reducing drying time and maintaining quality of ginger.

Bhuyan and Prasad (1990) conducted thin layer drying experiments on the Siliguri variety of ginger to study its drying characteristics and evaluated the quality of the dried product by determining its atile oil and oleoresin content. They also designed a small capacity tray dryer. The evaluation of the dryer showed that the performance was satisfactory at an air temperature of 60°C which was also found to be most suitable temperature for drying ginger slices.

Dash and Bhatnagar (1990) developed a multistage dehydration process for garlic. They employed drying air temperatures from 60, 70, 80 and 90°C up to 20, 30, 40 and 50 per cent cut off moisture levels. They recommended a two stage and three stage dehydration process which resulted in saving of about 16 and 17 per cent of total drying time respectively, compared to the single stage drying at 60°C.

Lee *et al.* (1995) developed an easy to operate; economical, micro computer controlled drying system and applied to the drying of ginger and onion.

It was found that temperature, relative humidity and sample weight could be measured and controlled successfully by using the system, which also resulted in improved product quality. They reported that the optimum drying conditions for ginger were 50°C and 25 per cent RH and that of onion were 65°C and 25 per cent RH.

Phillip *et al.* (1996) developed a tray type dryer for ginger drying. The preliminary evaluation tests conducted on the dryer reported that at an air temperature of 60°C the whole ginger was dried to moisture content of 11 per cent in 10 hours of drying time. The quality of the dried product was also found good.

Kim (1998) studied the mass transfer characteristics during the osmotic drying of ginger and its effect on quality. He found that the moisture loss during osmotic drying (using sugar solution at 60°Brix at 80°C with 18 min immersion time) was 40.05 g moisture per 100 g wet ginger which was equivalent to a 52 per cent reduction of initial moisture content of ginger (83.02% wb). It was also observed that the osmotically dried ginger softened more quickly than blanched ginger in boiling water.

Mudahar *et al.* (1989) studied the effect of temperature and time in a fluidized bed dryer, the concentration of biopolymer treatment and blanching time on quality attributes of dehydrated carrots using response surface methodology. Optimization maximized rehydration ratio and minimized bulk density and carotene loss. Based on surface responses and contour plots, optimum conditions were: drying temperature of 150ºC, exposure time of 12.5 minutes, biopolymer concentration of 1.40 per cent, and blanching time of 12 minutes. Experimentally determined values for rehydration ratio, bulk density, and carotene loss in product processed under the optimum conditions were very close to the predicted values of 9.5, 0.05, and 15.7 per cent, respectively.

Jose and Joy (2009) studied the freshly harvested turmeric rhizomes were collected from 30 stations and drying experiments were conducted by adopting methods solar tunnel drying, conventional drying and commercial drying. The results proved that conventional processing could maintain the intrinsic quality up to a certain level, but extrinsic quality could not be achieved. Solar tunnel drying method was an effective alternative to traditional open sun drying, where retention of curcumin, atile oil and oleoresin was high, with less drying time. The study also disclosed the importance of pre-drying and post-drying treatments and hygienic practices to be adopted during processing.

Apintanapong and Maisuthisakul (2011) the results revealed that microwave-vacuum drying rate (0.13-0.65 kg/kg.min) was higher than hot air drying rate at 60°C (0.06 kg/kg.min). In drying kinetic study, Page's models provided best fit model for both microwave-vacuum and hot air drying data with higher R2 in comparison with Newton=s model. Drying rate and drying coefficient (k) from both models tended to increase with microwave power, while an exponent (n) from Page=s model tended to decrease. It was found that microwave-vacuum drying at 300 mbar (vac) gave higher drying rate and drying coefficient than at 400 mbar (vac). Dried turmeric slices were ground and the color evaluation (L*, a* and b*) was done by a Hunter colorimeter to compare with hot air dried turmeric powder. Dried turmeric powder using microwave-vacuum drying had significantly higher lightness (L*) and yellowness (b*) while the redness (b*) was lower (P _ 0.05).

Gunasekar *et al.* (2011) the study indicated that the boiling and drying intensified the curcumin content, while the atile oil, oleoresin and total protein content progressively decreased as the moisture content decreased. The results also revealed that the solar drying is better than direct sun drying as it achieved the desired moisture and essential quality quality in 64 hours (8 days) compared to 96 hours (12 days) in sun drying, thus saving considerable time (32hours). Hence, the solar drying can be adopted for turmeric drying.

Sanchavat *et al.* (2012) the results indicate that boiling and drying intensified the colour and curcumin content. The results also revealed that the solar drying is better than direct sun drying as it achieved the desired moisture content and essential quality in 42 hour (6 days) compared to 56 hour (8 days) in sun drying, thus saving considerable time (14 hours). The economic feasibility of the biomass and solar energy system for turmeric processing was also carried out.

Martins *et al.* (2013) study was to evaluate the effects of the spray drying on curcuminoid and curcumin contents, antioxidant activity, process yield, the morphology and solubility of the microparticulated solid dispersion containing curcuma extract using a Box Behnken design. The microparticles were spherical in shape, and an increase in outlet temperaturefrom 40 to 80 °C resulted in a significant increase in the yield of microparticles from 16 to 53%. The total curcuminoid content (17.15 to 19.57 mg/g), curcumin content (3.24 to 4.25 mg/g) and antioxidant activity (530.1 to 860.3 μg/mL) were also affected by the spray drying process. The solubility of curcuminoid from C. longa remarkably improved 100-fold in the microparticles, confirming the potential of the ternary solid dispersion technique to improve the dyeing and nutraceutical properties of these compounds. Furthermore, the microparticles were obtained using the spray drying process, can be easily scaled up.

Bezbaruah *et al.* (2014) the effects of temperature and slice thickness on the drying kinetics of turmeric (*Curcuma longa*) slices are modeled to obtain a generalized master curve equation. Drying data obtained from experiments carried out in a laboratory scale tray dryer at different drying temperatures in the range of 40-70oC for different turmeric slice thicknesses (3-10 mm), are fitted to Midilli-Kucuk model (R2 > 0.992), the best fitted model among the common semi-theoretical models. To incorporate the temperature and slice thickness effects, temperature-thickness superposition technique was applied in two stages. In the first stage, at a given drying temperatures moisture ratio is expressed as a function of 'reduced time' ($t.a_h$) which is the product of drying time (t) and a thickness shifting factor (a_h). Thickness reduced master curves obtained at each temperature are again shifted by temperature shift factor (a_T) to generate a single master curve expressing moisture ratio as a function of another reduced time, t″, product of drying time (t), thickness shifting factor (a_h), and temperature shift factor (a_T), to obtain the generalized Midilli-Kucuk model ($MR(t.a_h.a_{T,})$). Temperature dependence of ah could be regressed into the Arrhenius - type equation, and aT could be regressed into a linear equation. The developed model was compared to the generalized drying model based on generalized drying rate constant, where upon both the models were found to yield prediction of turmeric slice drying with high accuracy (R2 value > 0.99).

2.3 Quality of the Final Product.

Pruthi *et al.* (1959) and Pruthi (1980) and reported that the quality of the dried product was affected by pre processing treatments, time, temperature and method of drying. They found that the temperature of drying air not only affects the drying time but also the quality of the dried product.

Rodriguez (1971) examined the colour of dried ginger treated with calcium oxide solution. He applied the process of steeping peeled ginger in plain water for 2 hours and then steeping with 1.5 to 2 per cent Calcium Oxide (lime) solution for 6 hours. He reported that pre-treatment of lime with ginger improved the colour of the dried product.

Natarajan *et al.* (1972) and Raina *et al.* (1978) studied the changes in the colour of ginger samples during drying and they observed that there was no significant difference in the colour of samples dried at temperatures between 50 to 60"C which indicated that the critical temperature of ginger was 60°C.

Sankari kutty *et al.* (1982) conducted experiments on ginger oil extraction from green ginger and noted that the ginger oil produced from coarsely ground rhizome required long time for distilling by steam distillation process due to the presence of large proportion of sesquiterpenes. They suggested that ginger peelings should also be distilled to avoid wastage of oil. Their investigation reported that Cochin ginger whole gave 1.9 per cent oil recovery and the peel 0.8 per cent oil.

Raina *et al.* (1988) conducted experiments on dehydration of six varieties of white onion to study their quality characteristics. It was reported that the rehydration ratio ranged from 1: 5.17 to 1: 6.17 for the onion slices of 3.5 mm thickness dried incross flow dryer at 60°C for 6 hours.

Tripathi and Nath (1989) have shown that dipping sliced tomato into 2.5 per cent starch solution containing 5 per cent potassium meta bisulphite and drying in a cabinet dryer yielded product of better quality than that obtained without pre treatment.

Kim *et al.* (1992) determined the drying kinetics of garlic pre-treated by immersion in 0.5 per cent metabisulphite solution at a temperature between 55 and 85°C. It was found that the quality of the dried product was considerably improved and an increase in rehydration ratio was also reported.

Yoonttee (1995) observed that the pre treatment of sodium metabisulphite reduced browning and destroyed micro organisms in dried ginger.

Yoonttee *el al.* (1995) studied the effects of drying conditions of ginger and storage methods of ginger powder on the qualities. They employed solar energy and hot air at temperatures 35, 50 and 65°C and investigations of the study indicated that drying of ginger in the sun improved its quality but took longer time than drying in hot air. It also stated that as hot air temperature was increased; browning of ginger slices was also increased. The conclusion was that sun drying was better than hot air drying based on the sensory tests of colour, flavour and taste of ginger powders.

Garg *et al.* (1999) reported that the oil content of turmeric rhizomes varied between 0.16 per cent and 1.94 per cent on a fresh weight basis. The rhizomes of all the accessions were also evaluated for their curcumin content, which was found to vary from 0.61 to 1.45 per cent on a dry weight basis.

Prasad *et al.* (2005) use of petroleum fuel or electricity for drying of agricultural produce is an expensive process at village scale in developing countries. Therefore, an appropriate technology for drying of agricultural produce has been developed and its performance for the drying of turmeric rhizomes has been evaluated. A direct type natural convection solar cum biomass drier was developed. The system is capable of generating an adequate and continuous flow of hot air temperature between 55 and 60 _C. Turmeric rhizomes were successfully dried in developed system. Dried turmeric rhizomes obtained under solar biomass (hybrid) drying by two different treatments viz., water boiling and slicing were similar in quality with respect to physical appearance like color, texture etc but there is significant variation in atile oil. The quantitative analysis showed that the traditional drying i.e., open sun drying had taken 11 days to dry the rhizomes while solar biomass drier took only 1.5 days and produced better quality produce. The efficiency of the whole unit obtained was 28.57%.

Tayyem *et al.* (2006) compared the quantitative amounts of curcumin that are present in several brands of turmeric and curry powders, a high performance liquid chromatography technique was used to analyze 28 spice products described as turmeric or curry powders and two negative controls. Pure turmeric powder had the highest curcumin concentration, averaging 3.14 per cent by weight.

Lin *et al.* (2006) developed a rapid method for the determination of curcumins in Chinese turmeric by micellar electrokinetic capillary chromatography (MEKC). Curcumin, dimethoxy curcumin and bis-dimethoxy curcumin were separated in less than 10 min using a 60 cm × 50 μm I.D uncoated fused-silica capillary column with a buffer consisting of 25 mM hydroxypropyl-β-CD (HP-β-CD), 10 per cent methanol, 40 mM sodium borate and 40 mM SDS (pH 9.50). The recovery efficiencies were 95.7-106.3 per cent. The calibration curves exhibited good linearity in the range of 90-1220 μg/mL (R=0.9996) for curcumin, 80-1120 μg/mL (R=0.9998) for dimethoxy curcumin and 80-1200 μg/mL (R = 0.9998) for bis-dimethoxy curcumin. Contents of curcumins in a methanol extract of turmeric sample could easily be determined by this method.

Dixit *et al.* (2009).the present surveillance has been undertaken to study the quality of loose versus branded turmeric powders *vis a vis* curcumin content and presence of unwarranted extraneous colors from city markets of India using a newly developed 2D-HPTLC method. Our results show that curcumin content in branded samples ranged from 2.2 to 3.7 % while non-branded samples had 0.3 to 2.6%. Though none of the branded turmeric powders contained artificial colors, 17% of loose powders showed the presence of extraneous color-metanil yellow, in the range of 1.0-8.5 mg g-1 which may pose health threats. Low curcumin content in the analyzed samples may be due to mixing of other curcuma species or their curcumin depleted matrices and foreign starches as cheaper alternatives. This is supported by the fact that major Indian turmeric trade types are known to possess curcumin contents ranging from 2.1-8.6 %, with an average of 4.8%. There is thus an urgent need to prescribe realistic curcumin limits for turmeric powder otherwise there is no obligation on the part of traders to stick to any minimum levels and consumers shall keep on getting this nutrient depleted household spice.

Surojanametakul *et al.* (2010) the result showed that the extracting solvent could significantly alter the curcuminoid as well as the total polyphenol content of the turmeric extract. Recommended conditions for curcuminoid extract from turmeric were: ethanol, solid:liquid ratio 1:50, at 70°C for 2 hr. Preparation of curcuminoid powder from turmeric extract was performed by entrapment of the natural turmeric compound "curcuminoid" with a polysaccharide, carboxymethyl cellulose, as a complex formation and mixed with maltodextrin, prior to drying. The curcuminoid content in the powder affected the product's qualities such as color, total phenolic compounds and antioxidant properties. Sensory evaluation of the products, in the form of turmeric tea, revealed that powder containing a level of curcuminoid of 411.28µg/g had the highest acceptance score. It also exhibited high water solubility (15g/100 ml). The total phenolic content and antioxidant capability of the product with the highest acceptance score was 13.27 as mg GAE/g and 14.46 as mg BHAE/g, respectively. The powder had a total plate count of yeast and mold <10 cfu/g and no pathogenic microorganisms were found. Storage of the powder in an aluminum foil bag at room temperature for four months only slightly changed the curcuminoid content, indicating the high stability of the product. Hence, curcuminoid powder could be used as a food ingredient for various health-drink products.

Benny *et al.* (2011) this study focused on screening of solvents for extraction of curcuminoids, isolation and purification of curcuminoids by column chromatography followed by purity analysis by HPLC. Different solvents were used for extraction, among them acetone showed maximum yield of each curcuminoids. Various solvent at different polarity were pre-tested in TLC for separation of curcuminoids, chloroform:methanol at 95:5 showed better resolution of Rf value at 0.75, 0.55, 0.27, as Curcumin(C),Demethoxycurcumin (DMC), Bisdemethoxycurcumin (BDMC) respectively. The acetone extract was subjected to silica gel column chromatography with chloroform: methanol at increasing polarity. Yield of each curcuminoid from column was determined and total curcuminoids of individual fractions of each curcuminoids were determined by UV spectrophotometry. Crystallization of each compound was done using chloroform: methanol (5:2) at 5°C. The isolated curcuminoids (C, DMC, and BDMC) showed single peaks at retention times of 10.81, 12.79, 13.03 min respectively on HPLC.

Ganpati *et al.* (2011) estimated the total curcumin content in turmeric by simple spectroscopic method using methanol extract of different samples of rhizomes. The linearity of calibration was obtained with coefficient of 0.99. It was found that curcumin content varied from fresh to stored rhizomes (3.426 ± 1.42 SD to 5.784 ± 1.32 SD) till storage up to 2.5 years. After 3 years sample showed decrease in curcumin content (3.186 ± 1.012 SD).

Gokhul *et al.* (2011) in this study, natural dye curcumin was extracted from 3 differenent varieties of 10 different rhizomes. Among 3 varieties, salem variety large finger (1.92 %) and bulb(1.88%) shows higher yield of curcurmin. Whereas No. 8 variety, in large finger (1.81%) and bulb (1.46%) of curcumin. In case of Erode variety, 1.36% from large finger and 1.33% from bulb. For separation of curcumin from demethoxycurcumin and bisdemethoxycurcumin, the mobile phase was prepared using chloroform and methanol in the ratio of 95:5 respectively. The maximum absorbance of the standard curcuminoid was observed at the wavelength of 420 nm with the absorbance of 0.545. Similarly, UV absorption spectra of natural dye solution exteracted from *Curcuma longa*.L was 0.743 at 420 nm. From the study, data are useful for further development of standard procedures. Whis this, we can improve extraction efficiency and purification of curcurmin from *Curcuma longa*. L.

Revathy *et al.* (2011) this study focused on screening of solvents for extraction of curcuminoids, isolation and purification of curcuminoids by column chromatography followed by purity analysis by HPLC. Different solvents were used for extraction, among them acetone showed maximum yield of each curcuminoids. Various solvent at different polarity were pre-tested in TLC for separation of curcuminoids, chloroform:methanol at 95:5 showed better resolution of Rf value at 0.75, 0.55, 0.27, as Curcumin(C), Demethoxycurcumin(DMC), Bisdemethoxycurcumin(BDMC) respectively. Theacetone extract was subjected to silica gel column chromatography with chloroform: methanol at increasing polarity. Yield of each curcuminoid from column was determined and total curcuminoids of individual fractions of each curcuminoids were determined by UV spectrophotometry. Crystallization of each compound was done using chloroform: methanol (5:2) at 5°C. The isolated curcuminoids (C, DMC, and BDMC) showed single peaks at retention times of 10.81, 12.79, 13.03 min respectively on HPLC.

Zhan *et al.* (2011) curcumin is an important food additive and a potential therapeutic agent for various diseases from turmeric, the rhizome of Curcuma longa L. High-efficient column chromatographic extraction (CCE) procedures were developed for the extraction of curcumin from turmeric. Turmeric powder was loaded into a column with 2-fold 80% ethanol. The column was eluted with 80% ethanol at room temperature. For quantitative analysis with a non-cyclic CCE, 8-fold eluent was collected as extraction solution. For large preparation with a cyclic CCE, only the first 2-fold of eluent was collected as extraction and other eluent was sequentially circulated to the next columns. More than 99% extraction rates were obtained through both CCE procedures, compared to a 59% extraction rate by the ultrasonic-assisted maceration extraction with 10-fold 80% ethanol. The CCE procedures are high-efficient for the extraction of curcumin from turmeric with minimum use of solvent and high concentration of extraction solution.

Amit *et al.* (2012) the objective of the present project work was to extract turmeric oil and to incorporate it into transdermal drug delivery system. Turmeric oil was obtained from the rhizomes of *Curcuma longa* collected from northeast region of India (26*55’30”N, 83*44’53”E). Extraction was carried out by hydro distillation using Clevenger’s apparatus following the method of Guenther (1948) at room temperature. The Rf value for curcumin determined by TLC was 0.70 that assures the purity of turmeric oil. Transdermal patches containing turmeric oil was formulated and evaluated for various parameters. The oil extracted was further incorporated into the polymers and examined for the compatibility issues. The transdermal patches were prepared using HPMC E50 and Poly Vinyl Alcohol in different ratio using Polyethylene glycol as plasticizer. The patches were evaluated for their physical properties like moisture content, flatness and thickness, weight variation, percentage elongation-break test. The physical properties of the prepared batches did not show any significant variations ($p>0.05$) and were found to have good physical integrity. Stability studies showed that the physical and chemical properties of the tested batches were not altered significantly and all the test formulations were found to be stable. The evaluation tests of fresh and aged transdermal patch showed no significant effect on drug release ($p > 0.05$).

Adinew (2012) the review intended to describe the phytochemistry of turmeric (curcumin longa). Turmeric contains a wide variety of phytochemicals, including curcumin demethoxycurcumin, bisdemethoxycurcumin, zingiberene, curcumenol, curcumol, eugenol, tetrahydrocurcumin, triethylcurcumin, turmerin, turmerones, and turmeronols. Among these, the most active component of turmeric is curcumin which gives a yellow color to turmeric and responsible for most of the therapeutic effects. The physico-chemical properties of curcumin are dependent on the pH of the medium. This review helps of chemists to understand the phytochemistry of curcumin and its medicinal values in a better way.

Bagchi (2012) Curcumin due to its various medicinal, biological, pharmacological activities is high on demand and has high market potential, high cost. Since curcumin has variety of uses, extracting it in a less expensive method other Super Critical Fluid Extraction is the main aim or objective of this work. Usage of food grade solvents is a main prerequisite of this work and optimization of the parameters in order to find an effective means of extraction sum ups the cause of this project work. Besides working on the extraction of curcumin, other properties such as curcumin’s antioxidant, antimicrobial properties are to be envisaged upon. This project work mainly deals with the topic on ‘extraction of curcumin’ from its common source turmeric, using an effective low cost method of solvent extraction. Different solvents are used either in their pure form or being mixed in definite ratio’s, while taking into consideration of other parameters such as particle size, time, temperature, solid: solvent ratio. The qualitative analysis of its antimicrobial property is also done along with the product development of Cake.

Dhanalakshmi and Jaganmohanrao(2012) the work was conducted to assess and compare the chemical composition of atile oils from fresh, dried and cured turmeric (Curcuma longa) rhizomes from a selected single source. In addition, their antioxidant and radical scavenging potentials were correlated with chemical composition. Major components were ar-turmerone (21.0–30.3%), ¿-turmerone (26.5–33.5%) and ˇ-turmerone (18.9–21.1%). Trolox equivalent antioxidant capacity (TEAC) values were 38.9, 68.0 and 66.9 _M at 1 mg of oil/ml for fresh, dried and cured rhizome respectively in ABTS assay. IC50 values for fresh, dried and cured rhizome oil to quench DPPH radicals were 4.4, 3.5 and 3.9 mg of oil/ml respectively. Fresh, dried and cured rhizome oils showed antioxidant capacity of 358, 686 and 638 mM of ascorbic acid equivalents per 1 mg of oil respectively. The rhizome oil shows good reducing potential and was concentration dependent. It is inferred that the cured rhizomes provided high yield of atile oil with appreciably high antioxidant potential.

Kulkarni *et al.*(2012) the present work reports on extraction method using Soxhlet extractor. Isolation and purification of curcuminoids was carried out by column chromatography. The quantification of curcumin in maximum resultant extract (by methanol) was performed using pre validated HPLC methodology. Percentage yield of curcumin by HPLC was 12.39% .extracted curcuminoids were subjected to spectrophotometer to check it's percentage amount in extracted sample. Different solvent were used for extraction, among them methanol showed maximum yield of each curcuminoids. Separation of curcuminoids were tested in TLC chloroform: methanol at 95:5 showed RF value at 0.67, 0.6, 0.506 as curcumin, dimethoxycurcumin,bis demethoxycurcumin respectively. the methanol extract was subjected to silica gel column chromatography with chloroform: methanol at increasing polarity followed by TLC to check purity of extracted curcumin.

Sawant (2013) turmeric is a spice derived from the rhizomes of Curcuma longa which is a member of the ginger family (Zingiberaceae). Rhizomes are horizontal underground stems that send out shoot as well as roots. The bright yellow colour of the turmeric comes mainly from fat soluble; polyphenolic pigments known as Curcuminoids. Plants shows medicinal properties as it contain phytochemical constituents. Phytochemical constituents are non nutritive plant chemical that have disease preventive properties. The rhizomes of Curcuma longa was extracted in Acetone, Methanol, Ethanol and Chloroform solvents giving 16.10, 15.42, 25.75 and 15.50% yields.

Muhamed *et al.* (2014) this paper reports an investigation of the bioactive "Curcumin" present in the crude plant extracts of 4 selected turmeric plants i.e. BSR-01, BSR-02, CL-101, CL-219. Curcumin is a significant spice that is extracted from the turmeric rhizomes (Curcuma longa L). It has several types of biological and pharmacological activities, including anticancer, anti-inflammatory and antioxidant properties, etc., Based on the various papers and reports about curcumin importance, we have shown more interest to deal the isolation process of curcumin from turmeric in the easy and fast manner with high recovery. This investigation was carried out to determine and compare the quantitative amounts of curcumin that are present in 4 different varieties of turmeric. The extraction of the herb curcumin from turmeric was attempted by using a "Soxhlet" solvent extraction technique with 95% ethanol as a solvent, then the quantification of curcumin in turmeric was normally based on spectrophotometric measurement. The presence of curcumin was confirmed by UV-Visible and elemental analytical techniques. Morphology studies (SEM) and XRD crystal studies were also investigated.

Wong-Yee *et al.* (2014) in this study, a solvent extraction method has been used to extract active compound which was curcumin in *Curcuma Longa.* Ethanol has been used as solvent to extract the curcumin. Rotary evaporator was used to purify the sample. The samples were put in rotovap at temperatures 40°C, 50°C, 60°C and 70°C. HPLC analysis showed that all of the samples had high percentage of curcumin. The antioxidant activity in 50°C curcumin extract showed the highest antioxidant activity with 24.968 M IC50 value while the lowest was the 70°C curcumin extract with 111.93 M IC50 value. The higher the IC50 value, the lower the antioxidant activity.

CHAPTER-III

MATERIALS AND METHODS

This chapter deals with the materials used and procedure adopted to achieve the objectives of the present investigation. This includes the description of experimental set up and methodology used in curing and drying of turmeric rhizomes, statistical analysis and quality evaluation methods.

The study was done in the Department of Agricultural Processing and Food Engineering, Swami Vivekananda College of Agricultural Engineering and Technology and Research Station, Faculty of Agricultural Engineering, Raipur, and Department of Crop Physiology, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh). The quality analyses were done in the R.H. Richharia Research Laboratory of the Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh).

3.1 Raw Material and Sample Preparation

The fresh turmeric rhizome of local variety (*Shillong*) was purchased from the Raipur local market and was used in the given experiment. The raw material was washed thoroughly in tab water to remove the adhering soil, hairs and extraneous matter. The undesirable portions were removed manually and then the rhizomes were again washed and cleaned properly.

The initial moisture content of turmeric rhizome samples was determined as described by Ranganna, (2000). A pre weighed small sample of turmeric rhizome was kept in a clean and weighed moisture box. The box was placed in oven and at 105°C for 8 hours. After 8 hours the moisture box was cooled in desiccators to a room temperature and then weighed. The moisture content was calculated by taking the difference between the initial weight of sample before drying and final weight after drying and divided by initial weight of sample before drying.

3.2. Method of Curing

3.2.1Traditional method of curing

In the traditional method, the cleaned rhizomes are boiled in copper or galvanized iron or earthen vessels, with water just enough to soak them. In certain places, cow dung slurry is used as boiling medium. Boiling is stopped when froth comes out and white fumes appear giving out a typical odour. The boiling lasts for 45 to 60 minutes when the rhizomes turn soft.

3.2.2 Improved scientific method of curing

In this method of curing the cleaned fingers (approximately 10 kg) are taken in a perforated trough of size 0.3×0.3m made of GI or MS sheet with extended parallel handle. The perforated trough containing the fingers immersed in the pan containing water. The alkaline solution (0.05, 0.1 and 0.2% sodium carbonate or sodium bicarbonate) is added into the water in which turmeric fingers are immersed. The wholesome is boiled till the fingers become soft. The cooked fingers are taken out of the pan by lifting the trough and draining the water into the pan. Alkalinity of the boiling water helps in imparting orange yellow tinge to the core of turmeric.

Table 3.1 Design details of the turmeric boiling pot

Boiling pot (Mild Steel)		Perforated barrel (Mild Steel)	
Height	51cm	Height	33cm
Width	41cm	Width	30cm
Thickness	0.2cm	Perforations	2.5cm
		Capacity	10kg

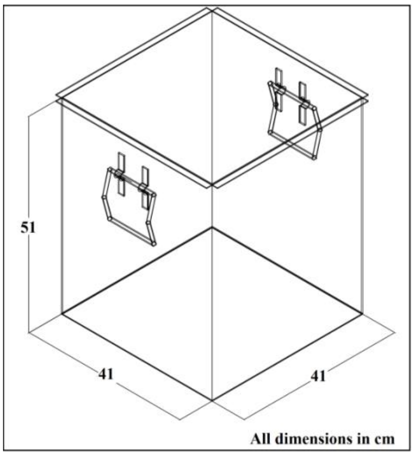

Fig. 3.1Modified boiling pot

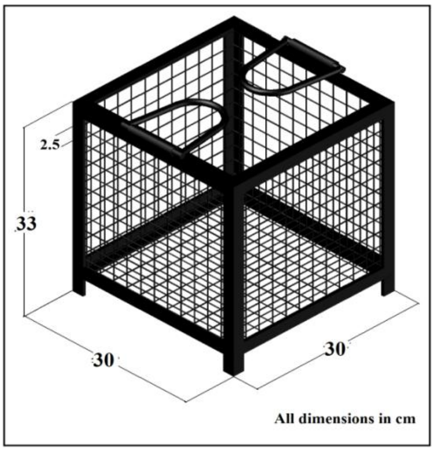

Fig.3.2 Perforated barrel

3.3. Pre-treatments

The present study was carried out to observe the effect of different pre-treatments on the drying characteristics at different temperature (50, 60, 70°C).

One of the common pre-treatment applied for turmeric rhizome is treating with different concentration of sodium bicarbonate at the time of boiling. The whole mass was boiled till the fingers became soft (Varshney *et al*., 2004). Boiling in alkaline water is said to improve the color (Pruthi, 1976).

The following pre-treatments were given to the turmeric rhizome. For each treatment the sample handled was 3 kg for curing/boiling and for non-boiling sample i.e. fresh rhizomes direct cut the sample was 1kg. Following are the details of independent and dependent variables taken consideration for study.

Independent variables		
Curing	Curing time, min	15, 30 and 45
	Sodium bicarbonate, %	0.05, 0.1 and 0.2
Convective	Air temperature, °C	50, 60 and 70
Non-curing	Sample size, cm	1, 2 and 3
Dependent variables		
Convective drying	Drying time, h	
	Drying rate, g water/ g dry matter-h	
Quality evaluation	Water activity, Curcumin content, Oleoresin content per cent	

3.4 Drying of Turmeric Rhizome

3.4.1 Mechanical tray dryer

The laboratory model tray dryer was used for conducting the drying experimental. It mainly consisted of a fan, air-heating chamber, temperature control unit, drying chamber, plenum chamber, hot air inlet, and outlet.

The tray dryer was operated at 1hp 3 phase 415 ts electric supply system. Air supplied by the fan was heated to the required temperature in the heating chamber, which was provided, with 8 heating coils. Inlet temperature of the air was varied by adjusting the control unit system.

The cross sectional area of the main vertical column of the drying chamber having external dimension was 1370 × 530 × 940 mm and internal dimension was 840×430×840. A door was provided on the front side of the chamber for placing and removing the sample holding trays. The details of the dryer are shown in Fig. 3.3 and the specifications are given in Appendix-B.

Turmeric rhizome of 3 kg and 1 kg for boiled and un-boiled direct cut sample respectively were taken and spread uniformly over the trays in single layer. Drying air temperature was adjusted to the desired level using the control unit. To study drying characteristics sample was weight after every 60 min interval by electronic balance. Airflow rate at the inlet and outlet of the drying chamber was measured by Anemometer. All the measured observations were recorded for further calculations. Drying was stopped when the drying mass reached the constant weight and no further drying takes place.

3.4.2 Vacuum oven

The laboratory model vacuum oven (Fig. 3.4) was used for conducting the experimental study. It mainly consist heating coil, temperature control unit, drying chamber and vacuum pump. This vacuum oven was used for providing pre-treatments to the non-boiled direct cut turmeric sample. For pre-treatment, temperature of vacuum oven kept constant at 60°C and at a pressure of 65 psi. The vacuum treatment provided to cut sample of thickness (1 & 2 cm) for reducing the total drying time. The vacuum oven drying method is shown in Fig. 3.4

Fig. 3.3 Tray dryer

Fig. 3.4 Vacuum Oven

Fig, 3.5 Turmeric cut rhizomes (1cm)

Fig. 3.6 Turmeric cut rhizomes (2cm)

Fig. 3.7 Turmeric cut rhizomes (3cm)

3.5 Convective Drying

Presently drying of agricultural commodities in the food processing industry is being done with help of various types of mechanical dryer's e.g. convective dryer, freeze dryer, infrared dryer, fluidized bed dryer, microwave dryer and solar dryer. Convective drying is the simplest and most economic method for dehydration of foods in convectional tray, cabinet or vacuum dryers.

3.5.1 Experimental procedure for convective drying of turmeric

The convective drying process is influenced by drying air temperature, air velocity, relative humidity, time of drying, loading density etc. Among these parameters listed above, the drying air temperature (T) and air velocity (V) were used in this study. The drying characteristics of the boiled rhizomes for 15, 30 and 45 min and un-boiled sample of 1, 2 and 3cm cut turmeric samples (Fig 3.5, 3.6 and 3.7) were studied. The boiled and un-boiled samples were dried in the laboratory tray dryer at 50, 60 and 70°C drying air temperatures and at constant air velocity of 1 m/s.

3.5.2 Drying characteristics

The initial weight of the sample was recorded after 1hours intervals until no further reduction in moisture content i.e. the final moisture content of was 0.08g water/g dry matter. The sample weight loss during drying was co-related with moisture content on dry basis and expressed as a g water/g dry matter. The drying data were analyzed to study the drying behaviour of given samples**.**

3.5.3 Moisture content during drying

Moisture content of the sample during experiments at various times was determined on basis of dry matter of the sample. Moisture content (wb) during microwave drying was calculated as (Brooker *et al.,* 1974):

$$\text{Moisture content (wb)} = \frac{W_\theta - DM}{W_\theta} \times 100 \qquad \ldots (3.1)$$

Where,

W_θ = Weight of sample at time θ, g

DM = Dry matter of the sample, g

3.5.4 Drying rate

The moisture content data recorded during experiments was analyzed to determine the moisture lost from the samples in particular time interval. The drying rate of sample was calculated by following mass balance equation (Brooker *et al.*, 1974).

$$R = \frac{\text{WML (kg)}}{\text{Time interval (min) x DM (kg)}} \qquad \dots (3.2)$$

Where,

R = Drying rate at time θ, kg water/ kg, min

WML = Initial weight of sample – Weight of sample after time θ

3.5.5 Dry matter

It is the matter left after complete removal of moisture from the product. The initial moisture content of various samples was determined by oven drying method, as described earlier. The dry matter percentage and weight of dry matter in sample were calculated as follows (Brooker *et al.* 1974):

DM (%) =100 - IMC (%wb

$$\text{Weight of DM} = \text{Initial mass of sample} \times \frac{\text{DM}(\%)}{100} \qquad \dots (3.3)$$

3.5.6 Moisture ratio

The moisture ratio (MR) at each moisture content level was determined by the following equation:

$$MR = \frac{M - M_e}{M_o - M_e} \qquad \dots (3.4)$$

Where,

MR - Moisture ratio

M - Moisture content at any time (db)

M_o - Initial moisture content (db)

Me - Equilibrium moisture content (db)

3.5.7 Moisture diffusivity

In drying, diffusivity is used to indicate the rapidness of flow of moisture or moisture out of material. In falling rate period of drying, moisture is transferred mainly by molecular diffusion. Diffusivity is influenced by shrinkage, case hardening during drying, moisture content and temperature of material (Singh, 2001; Karim and Hawaldar, 2005).

The falling rate period in drying of biological materials is best described by simplified mathematical Fick's second law diffusion. (Crank, 1975) as given below.

$$\frac{\delta M}{\delta t} = D\frac{\delta^2 M}{\delta X^2} \qquad \text{… (3.5)}$$

Where,

D = Diffusion coefficient, m^2/s

M = Moisture content, g water per g dry matter

X = characteristic dimension i.e. distance of surface from the centre line of product, m

T = Time elapsed during the drying, s

The method of slopes was used in the estimation of effective moisture diffusivity of turmeric rhizomes and slices at corresponding moisture contents under different drying conditions.

3.5.7.1Diffusion coefficient for turmeric rhizomes (Infinite cylinder)

The turmeric rhizome were assumed as infinite cylinder i.e. moisture diffusion occurring radially outwards only (Crank, 1975) and following assumptions were made for the infinite cylindrical shaped body of the turmeric rhizomes.

1. Moisture is initially uniformly distributed throughout the mass of a sample.
2. Mass transfer is symmetric with respect to the centre.
3. Surface moisture content of the sample instantaneously reaches equilibrium with the condition of surrounding air.

4. Resistance to the mass transfer at the surface is negligible compared to internal resistance of the sample.
5. Moisture transfer is by diffusion only.
6. Diffusion coefficient is constant and shrinkage is negligible

Eq^n 3.7 can be solved for infinite slab as follows:

$$MR = \frac{M - M_e}{M_0 - M_e} = \sum_{n=1}^{\infty} \frac{4}{\beta^2} \exp\left[-\frac{\beta^2 D_{eff}\, t}{r_c^2}\right] \qquad \text{... (3.6)}$$

Where,

D_{eff} = Effective diffusivity, m^2/s

MR = Moisture ratio, dimensionless

M = Moisture content, g water per g dry matter

M_0 = Initial moisture content, g H_2O/g dry matter

M_e = Equilibrium moisture content, g H_2O/g dry matter

r_c = cylinder radius, m

β = root of the Bessel function =2.4048,(Souraki and Mowla,2008)

T = Time elapsed during the drying, s.

On simplification of equation 3.7

$$MR = \frac{M - M_e}{M_0 - M_e} = \frac{4}{\beta^2} \exp\left[-\frac{\beta^2 D_{eff}\, t}{r_c^2}\right] \qquad \text{… (3.7)}$$

Taking log and rearranging the equation (3.8) as.

$$MR = \frac{M - M_e}{M_0 - M_e} = \ln \frac{4}{\beta^2} - \left[\frac{\beta^2 D_{eff}\, t}{r_c^2}\right] \qquad \text{… (3.8)}$$

$$\ln[MR] = -0.3686 - \left[\frac{\beta^2 D_{eff}\, t}{r_c^2}\right] \qquad \text{… (3.9)}$$

A general form of above eq^n can be written as,

$$\ln(MR) = A - Bt \qquad \text{… (3.10)}$$

Where,

A is constant and B is slope of equation 3.6

A= -0.3686

$$B = Slope = \left[\frac{\beta^2 \, D_{eff}}{r_c^2} \right] \qquad \dots (3.11)$$

Experimental values of the effective diffusivity are typically calculated by plotting experimental drying data in terms of ln (*MR*) versus drying time t. It gives a straight line and the slope of the line would be used to measure the moisture diffusivity (Eq. 3.10). This approach was a simplified one and shrinkage of the material was not taken into consideration, i.e. thickness of the material r_c was assumed constant throughout the drying process

$$\text{Slope} = \frac{\beta^2 D_{eff}}{r_c^2} \qquad \dots (3.12)$$

3.6 Water Activity Determination

Moisture plays an important role in the stability of fresh, frozen and dried foods. It acts as a solvent for chemical, microbiological and enzymatic reactions. Water activity is a measure of the availability of water to participation in such reactions. Moisture in a food will exert a vapour pressure. The extent of this pressure will depend on the amount of moisture present, the temperature and the composition of the food. Different food components will lower the water vapour pressure to different extents, with salts and sugars being more effective than starches or proteins. Thus two different foods with similar moisture contents may not necessarily have the same $a_{w.}$

A digital Pawkit Water activity meter was used in measuring water activity of the different treated samples (Fig 3.8). The sample used was just enough (8-10 grams) to cover the filling indicator cup. The filled sample cup was kept in contact with sensor probe of Pawkit water activity meter which record the value and the specifications are given in Appendix-C.

Fig. 3.8 Water activity measurement

3.7 Quality Evaluation

Food quality is one of the very important parameter in food processing to ensure best quality finished products. Control should be exercised at every stage from pre-processing to packaging, storage etc. Quality of dehydrated turmeric powder was evaluated on the basis of several parameters viz. colour and biochemical analysis.

3.7.1 Biochemical analysis

Turmeric is mainly exported in the form of powder. The commercial value of turmeric is mainly depending upon its characteristics curcumin and oleoresin content. The presence of curcumin and oleoresin content was affected by the various process parameters such as temperature, air velocity and duration of process time. While evaluating the quality of dried product, the effect of these process parameters on oleoresin and curcumin content is essential. Thus the biochemical analysis was carried out to evaluate these components. A biochemical analysis includes determination of oleoresin content and curcumin content of dried products.

Fig.3.9 Use of spectrophotometer

Fig. 3.10 Column extraction process of turmeric powder

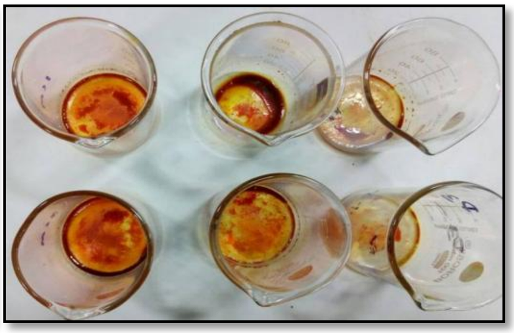

Fig.3.11 Oleoresin content after drying extract

3.7.1.1 Curcumin content

The polyphenolic content of turmeric or curcuma root, extracted as an orange yellow crystalline substance, with a green fluorescence is known as curcumin, $C_{21}H_{20}O_6$ having melting point of 184-185°C was isolated as early as 1815 (Vogel and Pelletier, 1818). It is insoluble in water but soluble in ethanol and acetone. Curcumin is the product obtained by solvent extraction of ground turmeric rhizome and purification of the extract by crystallization.

The spectrophotometer method (Fig. 3.9) was used for the estimation of curcumin because it was simple, easier, cheaper and feasible method in our laboratory condition. In the present investigation curcumin content in rhizome of curcuma longa was determine by solvent extraction followed by spectrophotometer method. The detail procedure has been described below (Joshi *et al.*, 2009).

3.7.1.1.1 Extraction of Curcumin content

0.1gm of dried extract was dissolved in 25ml of ethanol, this solution was filtered and ume made upto100ml. Then 10 ml of above solution was taken in umetric flask and again ume made up to 100 ml with ethanol. The absorbance was measured using spectrophotometer at 425nm (Soni Himesh *et al.*, 2011).

A standard curcumin 0.25g/lit give absorbance at 425nm = 0.42
Absorptive of curcumin (A)

= 0.42/1 × 0.025 =16.8

$$\%\ \text{curcumin} = \frac{a \times 100}{L \times A \times W} \qquad \text{... (3.13)}$$

Where,

a = absorbance of sample at 425nm
L= path length (1cm)
A = absorptivity.

3.7.1.2 Estimation of Oleoresin content

The simplest form of solid-liquid extraction is the treatment of a solid with a solvent. Column extraction apparatus (Fig. 3.10 - 3.11) was used for extraction of turmeric oleoresin from dried turmeric powder (Shahidi 2001). Ethanol was used as solvent for the extraction of turmeric oleoresin.

In the present work, oleoresin was quantitatively extracted in column extraction method by using 95% ethanol as a solvent. The dried turmeric powder were taken at the rate of 5.0g was loaded in glass columns blocked with non-absorbent cotton. Ethanol (15ml) was allowed to percolate down into the glass column and kept in and the contact was maintained for overnight. Soluble extracts were then drained off into a pre-weighed 100 ml beaker. All the extracts were pooled which was then evaporated to near dryness and the final weight recorded. The same procedure was followed to isolate oleoresin by using ethanol as a solvent. After drying the extract weights were noted.

In this work of different treatment turmeric powder were used to determine the content of oleoresin. The extracted oleoresin is calculated by using the following formula and expressed as percent (ASTA, 1983).

$$\text{Oleoresin content (db)}\% = \frac{W2 - W1}{10} \times 100 \qquad \text{... (3.14)}$$

Where,

W_1 = Weight of empty beaker

W_2 = Weight of beaker with turmeric oleoresin content

CHAPTER - IV

RESULTS AND DISCUSSION

In this chapter the results and discussion are presented which were obtained during the experimental work. The chapter deals with the study of different traditional turmeric processing methods followed in different turmeric growing area of the state of Chhattisgarh and the standardization of suitable one. Also the chapter explains time reduction technology for the processing of turmeric and the quality evaluation (physical and biochemical) of final produce. The results have been presented and interpreted under suitable headings and sub-headings.

The initial moisture content of turmeric was determined by oven methods found to be 77 percent (wb). The moisture content of turmeric after curing (15, 30 & 45 min with 0.05, 0.1 & 0.2 percent of sodium bicarbonate) was found in the range of 78.22 to 79.75 percent (wb) and the cut sample turmeric rhizome without curing but vacuum drying for 1 h, the moisture content was reduced up to 74.85 percent (wb) as shown in Appendix-A.

4.1 Traditional Turmeric Processing Methods Used In the State

In Chhattisgarh, the turmeric crop was grown in different parts; about 50% of these crop growers are tribal and are generally grown in backyard with their indigenous methods of crop production. The state contributes about 11.80 percent of total India's turmeric cultivation in terms of area. The production of turmeric in the state is nearly 83,470 Mt from 9,747 ha of land (Annual report of horticulture, 2013-14). The major turmeric growing area of the state is; Korba, Jagdalpur, Sarguja, Jashpur, Kondagaon, Balod, Surajpur and Balrampur.

As per the survey conducted in the turmeric growing area following three methods are observed for turmeric processing.

1. Curing/boiling of turmeric with cow dung
2. Curing/boiling of turmeric without cow dung but cutting of rhizomes into slices of 2-3 cm thickness before sun drying
3. Curing/boiling of turmeric without cow dung – commercial method

4.1.1 Traditional method – curing/boiling of turmeric with cow dung

In this method, the harvested fresh turmeric rhizomes are washed first and the finger rhizomes are separated from mother rhizomes and both the rhizomes are process separately. After washing rhizomes are placed in an aluminum vessel or galvanized iron or earthen vessels, with water just enough to soak rhizomes completely and the small amount of cow dung slurry is added. The curing is done up to 45-60 min that rhizomes cooked completely and feel soft (Fig. 4.1 & 4.3). After curing, the excess water is drain out and the rhizomes are placed for open sun drying. The detailed flow chart of the method is given in Fig. 4.1.

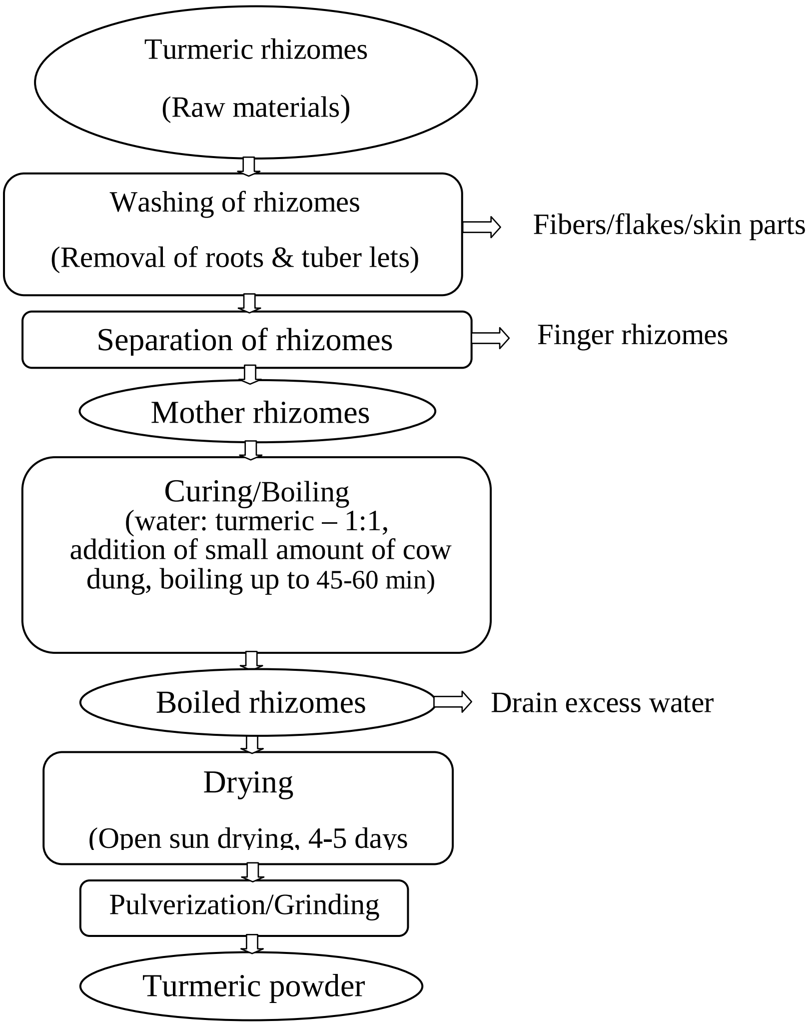

Fig. 4.1. Traditional processing of turmeric with cow dung

Fig. 4.2 Boiling of raw turmeric in aluminum pot

Fig. 4.3 Examination of boiling process

4.1.2 Traditional method – curing/boiling of turmeric without cow dung

In this processing method raw turmeric rhizome are washed thoroughly and separate the finger and mother rhizomes which are then process separately. The mother rhizomes were boiled in aluminum pots along with normal water just enough to soak rhizomes completely (Fig. 4.4). The rhizomes are boiled about 45-60 minutes by covering the pot with a lid or up to the white froth appears with a special quality flavor which was guess by experience person. The cooking process is completed when rhizomes become soft and inner colour turns yellow (Fig. 4.5). After boiling, the excess water is drain out and the boiled rhizomes were cut into small pieces (2-3 cm) horizontally and then kept for dried in open sun by spreading them in 5-7 cm thick layers on bamboo mats or ground floor for 4-6 days. During drying rhizomes are stirred 2-3 times to ensure uniform drying. During night time, the rhizomes are heaped and covered. The flow chart is given in Fig.4.6.

4.1.3 Commercial method – curing/boiling of turmeric without cow dung

In this processing method, harvested fresh turmeric rhizomes are washed with help of high pressure water to remove field dust/soil. In this method rhizomes were boiled in a tar drum which was special designed (Fig 4.10 to 4.11). In this tar drum one inner drum (mesh type) is present in which rhizomes are present which were dip in water holding drum. The washed rhizomes are boiled in a tar drum having 0.8 m height and diameter of 0.53 m. In this process water is first boiled and then rhizomes are poured into the water. The rhizomes are boiled up to 45-60 minutes or up to the white fumes appear with typical smell. After boiling, the inner drum (mesh type) is removed and put on drying platform for drying (Fig. 4.10 to 4.11). The flow chart is given in Fig.4.9.

Fig.4.4 Boiling of raw turmeric in aluminum pot

Fig. 4.5 Examination of boiling process

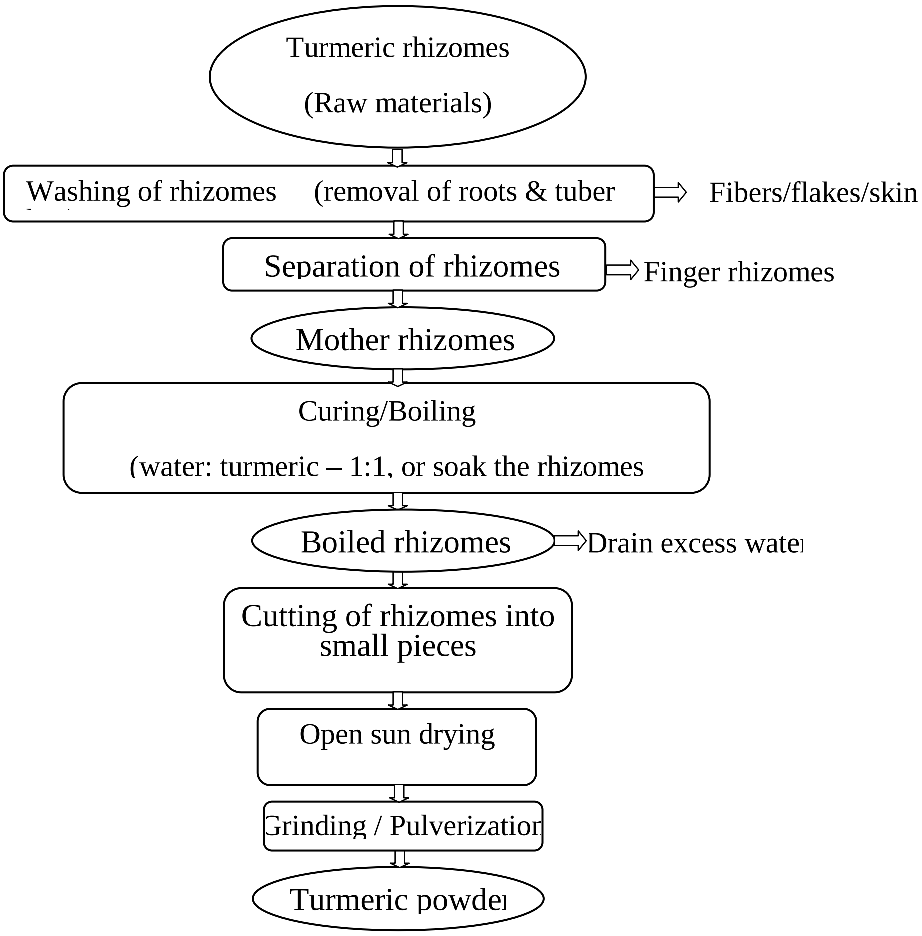

Fig. 4.6 Traditional processing of turmeric without use of cow dung

Fig. 4.7 Cutting of boiled rhizomes into small pieces

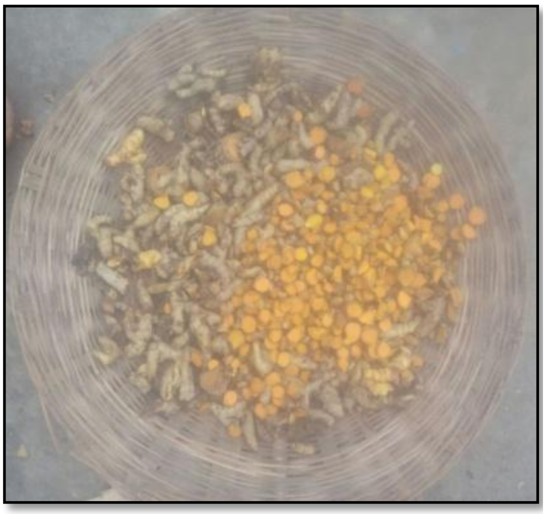

Fig.4.8 Open sun drying of rhizomes

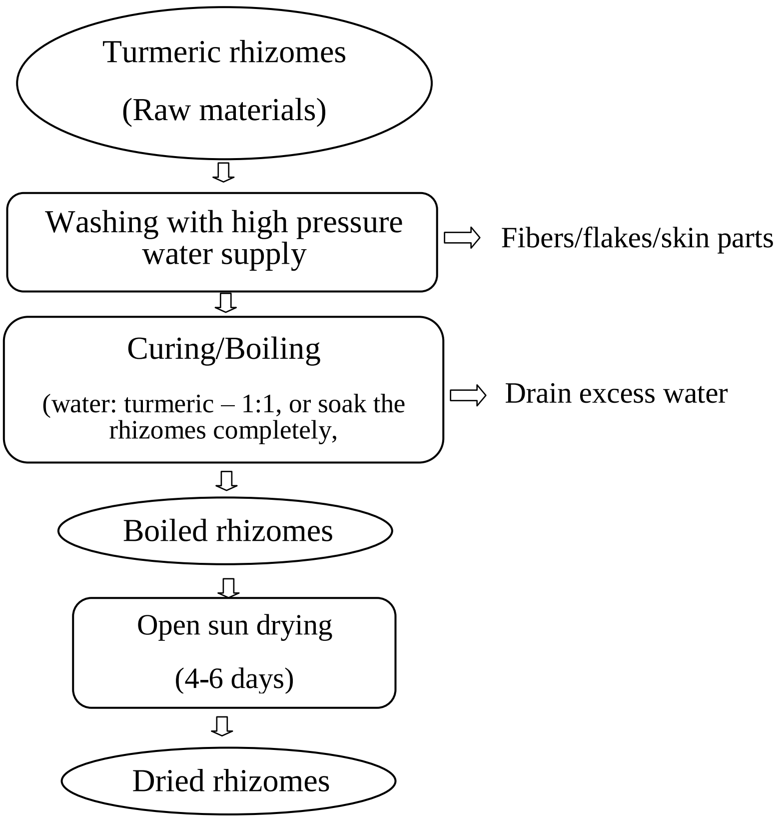

Fig. 4.9 Commercial method of turmeric processing

Fig. 4.10 Process of boiling of turmeric rhizomes

Fig. 4.11 Drying of boiled rhizomes in open

4.2 Standardization of Turmeric Processing Method

For the standardization of turmeric processing method; sodium bicarbonate percent (0.05, 0.10, & 0.20%), curing/boiling time (15, 30, & 45 min), and mechanical drying temperature (50, 60 & 70°C) are selected and on the basis drying characteristics, drying time and final quality of produce best suitable method of turmeric processing was selected.

4.2.1 Convective drying of turmeric

In this part, the result of convective drying has been presented. The sample of turmeric after curing was dried in a tray dryer at 50, 60 and 70°C drying air temperatures. The air-flow rate of the drying air was kept constant i.e 1.0 m/s throughout the drying period. The weight of the turmeric sample was taken after every 60 min intervals for the entire experiments i.e. till the sample attained constant weight. As the initial moisture content of turmeric sample i.e. after curing process was known, the moisture content, amount of water removed, and rate of drying at various intervals were determined by mass balance equation. The data of drying characteristics viz. moisture content and drying rate were computed and presented in Appendix-D. The result of tray drying has been discussed in the following sections.

4.2.1.1 Variation in moisture content with time

The change in moisture content of pre-treated (curing/boiling) turmeric sample during convective drying was calculated. In general it was found that it took approximately 32-99 hours of air drying to reduce the moisture content of turmeric sample to safe level storage or grinding. The variation in drying time was expected due to different in moisture content of turmeric sample after different curing treatments and due to the difference in air drying temperature. Further, it was also observed that the reduction in moisture content was faster in the initial period of drying (Fig. 4.12 – 4.14). This was in accordance to general trend for air drying as noted by many investigators because during initial period of drying the resistance to water diffusion is less and due to higher rate of drying more amount of water could be removed from the food materials. (Madambe *et al*. 1996 and Sarsavadia *et al*. 1999 for drying of garlic and onion slices).

A. For 15 minutes of curing time

The typical drying curves showing variation in moisture content with drying time in Fig. 4.12. Which depict the effect of different drying temperatures (50, 60 & 70°C) on drying time of turmeric samples, which were boiled for 15 min in three different concentration of sodium bicarbonate (0.05, 0.1 & 0.2 %) and subsequently dried in tray dryer.

It could be seen from the Data sheet 1-3 of Appendix D that the initial moisture content of the turmeric was in the ranges from 75-76 percent (wb) which was increased to 78.22-78.43 percent (wb) after boiling for 15min in different concentration of sodium bicarbonate (0.05, 0.1 and 0.2 percent).

It can be observed from Fig. 4.12 that it took 42-99 h of drying time in tray dryer to reduce the moisture content to 3.36 percent (wb).

It would be observed from these curves that moisture content of turmeric sample decreased exponentially with drying time under all drying conditions. Similar results were obtained by Pokharkar (1994) and Vergara *et al.* (1997) for air drying of osmotically dehydrated banana and apples respectively.

B. For 30 minutes of curing time

The typical drying curves showing variation in moisture content with drying time in Fig. 4.13. Which depict the effect of different drying temperatures (50, 60 & 70°C) on drying time of turmeric samples, which were boiled for 30 min in three different concentration of sodium bicarbonate (0.05, 0.1 & 0.2 %) and subsequently dried in tray dryer.

It could be seen from the Data sheet 1-3 of Appendix D that the initial moisture content of the turmeric was in the ranges from 75-76 percent (wb) which was increased to 78.50-78.70 percent (wb) after boiling for 30 min in different concentration of sodium bicarbonate (0.05, 0.1 and 0.2 percent).

It can be observed from Fig. 4.13 that it took 39-88 h of drying time in tray dryer to reduce the moisture content up to 3.47 percent (wb). It was observed that, the drying time required for the samples which were boiled for 30 min were less than that of sample of 15 min boiled of all concentration of sodium bicarbonate. It would be observed from these curves that the moisture content of turmeric sample decreased exponentially with drying time under all drying conditions.

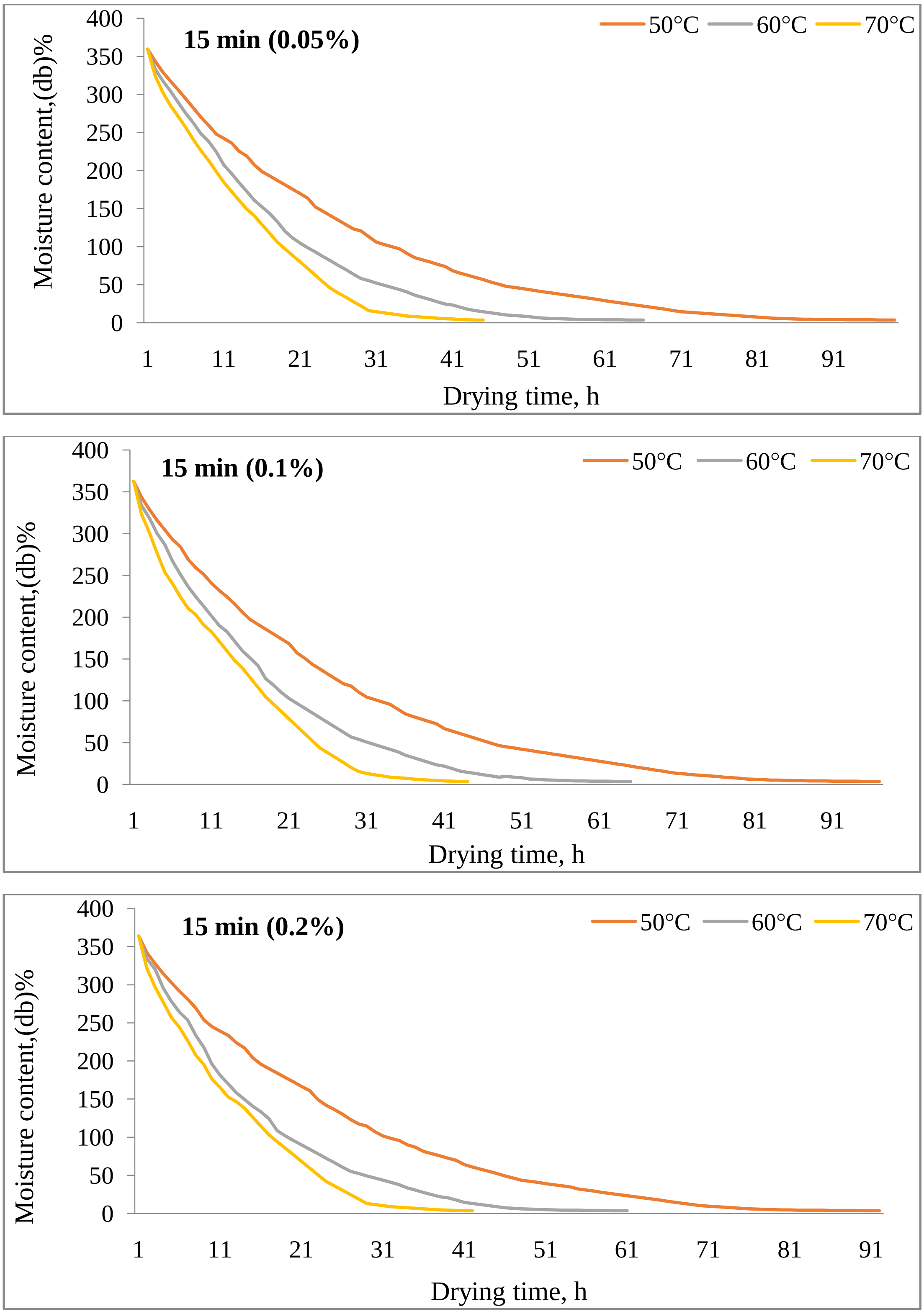

Fig.4.12 Variation of moisture content with drying time of turmeric sample for 15 min boiling time and at three different concentrations of sodium bicarbonate

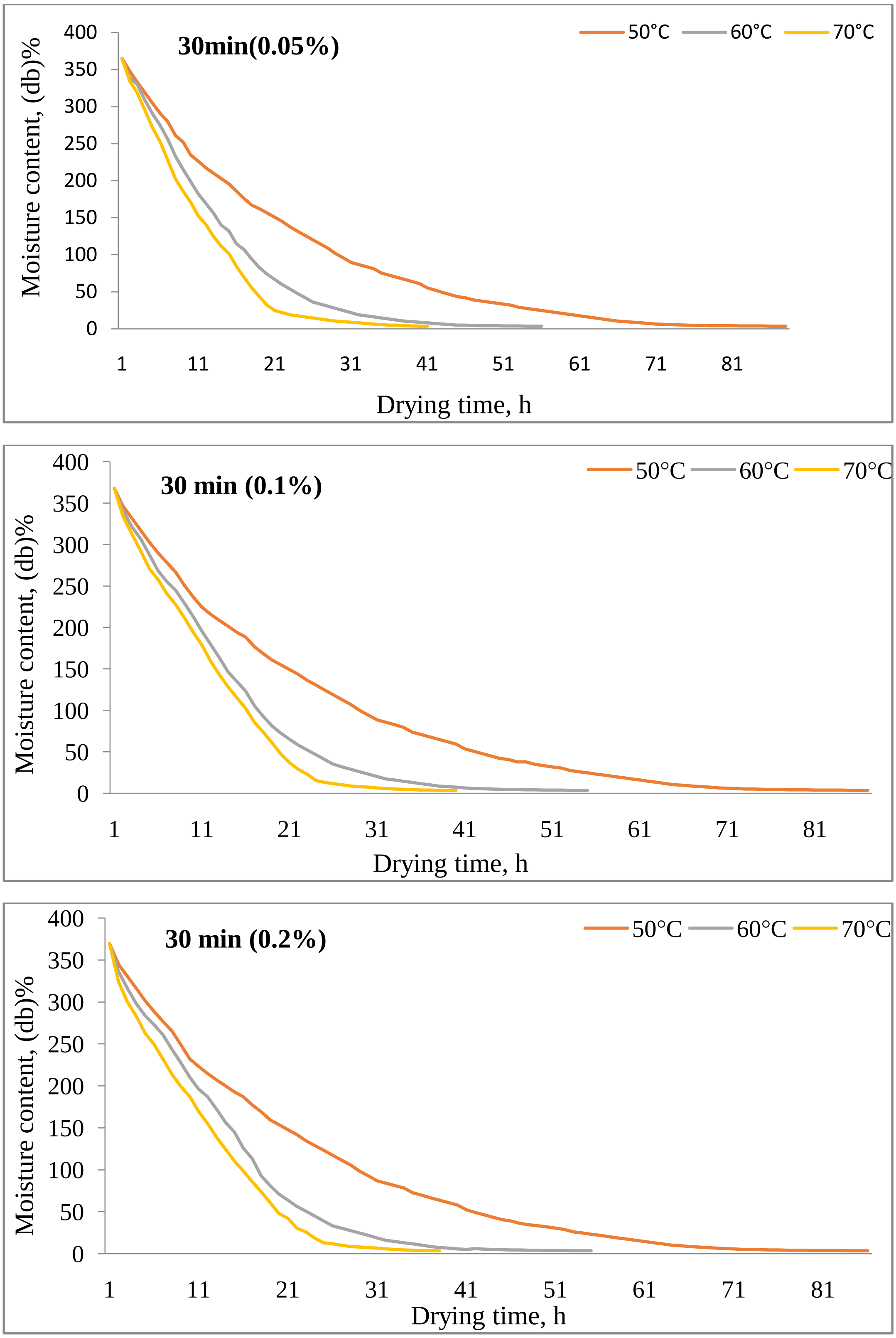

Fig. 4.13 Variation of moisture content with drying time of turmeric sample for 30 min boiling time and at three different concentrations of sodium bicarbonate

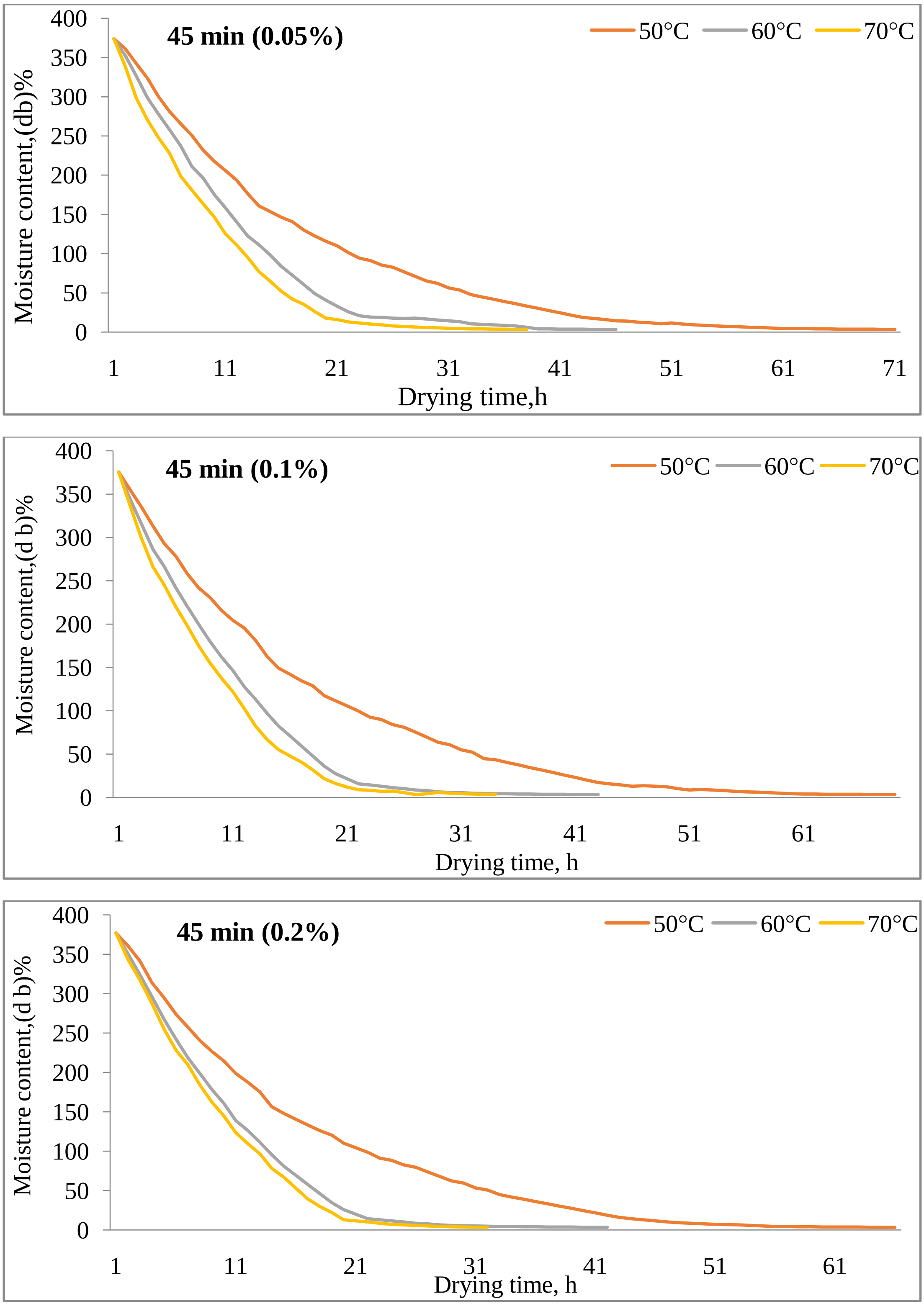

Fig. 4.14 Variation of moisture content with drying time of turmeric sample for 45 min boiling time and at three different concentrations of sodium bicarbonate percent

C. For 45 minutes of curing time

The typical drying curves showing variation in moisture content with drying time in Fig. 4.14. Which depict the effect of different drying temperatures (50, 60 & 70°C) on drying time of turmeric samples, which were boiled for 45 min in three different concentration of sodium bicarbonate (0.05, 0.1 & 0.2 %) and subsequently dried in tray dryer.

It could be seen from the Data sheet 1-3 of Appendix D that the initial moisture content of the turmeric was in the ranges from 75-76 percent (wb) which was increased to 78.89-79.02 percent (wb) after boiling for 45 min in different concentration of sodium bicarbonate (0.05, 0.1 and 0.2 percent).

It can be observed from Fig. 4.4 that it took 32-71 h of drying time in tray dryer to reduce the moisture content up to 3.63 percent (wb). It was observed that, the drying time required for the samples boiled for 45 min was less than that of sample boiled for 15 min and 30 min. The details of drying time required in various treatments and drying temperature was given in Table 4.1.

4.2.1.2 Drying rate curve

As the moisture content of turmeric sample after boiling was known and the weight of turmeric after subsequent time interval were determined during tray drying, the moisture content, amount of water removed and the rate of drying at various time interval were calculated by mass balance equation. The data for drying characteristics viz. moisture content and drying rate were computed and presented in Appendix D. The drying rate data plotted against the moisture content have been illustrated in Fig. 4.15 – 4.17.

In general, it was found that the complete drying of turmeric sample after the boiling process took place in the falling rate period and the constant rate period was completely absent in all the tray dried samples. The drying in falling rate period indicates that, internal mass transfer occurred by diffusion. Similar results have been reported for the drying studies on onion slices (Rapusas & Driscoll, 1995) and apricots (Doymaz, 2004).

It was observed from the curves that the drying rate was higher in the initial period of drying and subsequently it was reduced with decrease in moisture content. The effect of curing time (15, 30 and 45 min), percent of sodium bicarbonate (0.05, 0.1and 0.2 %) and drying temperature (50, 60 and 70ºC) on rate of drying and moisture content has been discussed in the following sections.

Table 4.1 Drying times of turmeric rhizome under various treatments and drying temperature

S. No.	Curing/boiling Time (min)	Sodium bicarbonate (%)	Drying Temperature (°C)	Drying time (h)
1	15	0.05	50	99
2	15	0.05	60	66
3	15	0.05	70	45
4	15	0.10	50	97
5	15	0.10	60	65
6	15	0.10	70	44
7	15	0.20	50	92
8	15	0.20	60	61
9	15	0.20	70	42
10	30	0.05	50	88
11	30	0.05	60	56
12	30	0.05	70	41
13	30	0.10	50	87
14	30	0.10	60	55
15	30	0.10	70	40
16	30	0.20	50	86
17	30	0.20	60	54
18	30	0.20	70	39
19	45	0.05	50	71
20	45	0.05	60	46
21	45	0.05	70	38
22	45	0.10	50	66
23	45	0.10	60	43
24	45	0.10	70	34
25	45	0.20	50	65
26	45	0.20	60	42
27	45	0.20	70	32

A. For 15 minutes of curing time

The effect of drying temperature (50, 60 and 70°C) on drying rate of samples which was boiled for 15 min with three different concentration of sodium bicarbonate (0.05, 0.1 and 0.2%) has been presented in Fig 4.15.

It may be observed from the Fig. 4.15 that the constant rate period of drying was totally absent throughout the drying process and complete drying took place in the falling rate period for all the experiments. Initial drying rate of 0.36 g water/g dry matter-min was observed for turmeric samples dried at 50°C with 0.05 percent of sodium bicarbonate. This drying rate reduced continuously during 98 h of drying time, whereas initial drying rate for turmeric samples dried in tray dryer at 60 and 70°C with 0.05 percent sodium bicarbonate was found to be 0.43 and 0.57 g water/g dry matter-min, respectively.

For the turmeric sample boiled for 15 min with 0.1 and 0.2 percent of sodium bicarbonate the drying rate of 0.31 and 0.36 g water/g dry matter-min was observed respectively for 50°C drying air temperature. For drying air temperature of 60°C and 70°C, the drying rate of 0.48 and 0.65 g water/g dry matter-min was observed for 0.1 percent sodium bicarbonate respectively.

Also for drying air temperature of 60°C and 70°C, the drying rate of 0.55 and 0.70 g water/g dry matter-min was observed for 0.2 percent sodium bicarbonate respectively.

B. For 30 minutes of curing time

The effect of drying temperature (50, 60 and 70°C) on drying rate of samples which was boiled for 30 min at three different concentration of sodium bicarbonate (0.05, 0.1 and 0.2%) has been presented in Fig. 4.16.

It may be observed from the Fig. 4.16 that the constant rate period of drying was totally absent throughout the drying process and complete drying took place in the falling rate period for all the experiments. Initial drying rate of 0.28 g water/g dry matter-min was observed for samples dried in tray dryer at 50°C with 0.05 percent of sodium bicarbonate. This rate reduced continuously during 88 h of drying time, whereas initial drying rate for turmeric samples dried in tray dryer at 60 and 70°C drying air temperature with 0.05 percent sodium bicarbonate was found to be 0.43 and 0.50 g water/g dry matter-min, respectively.

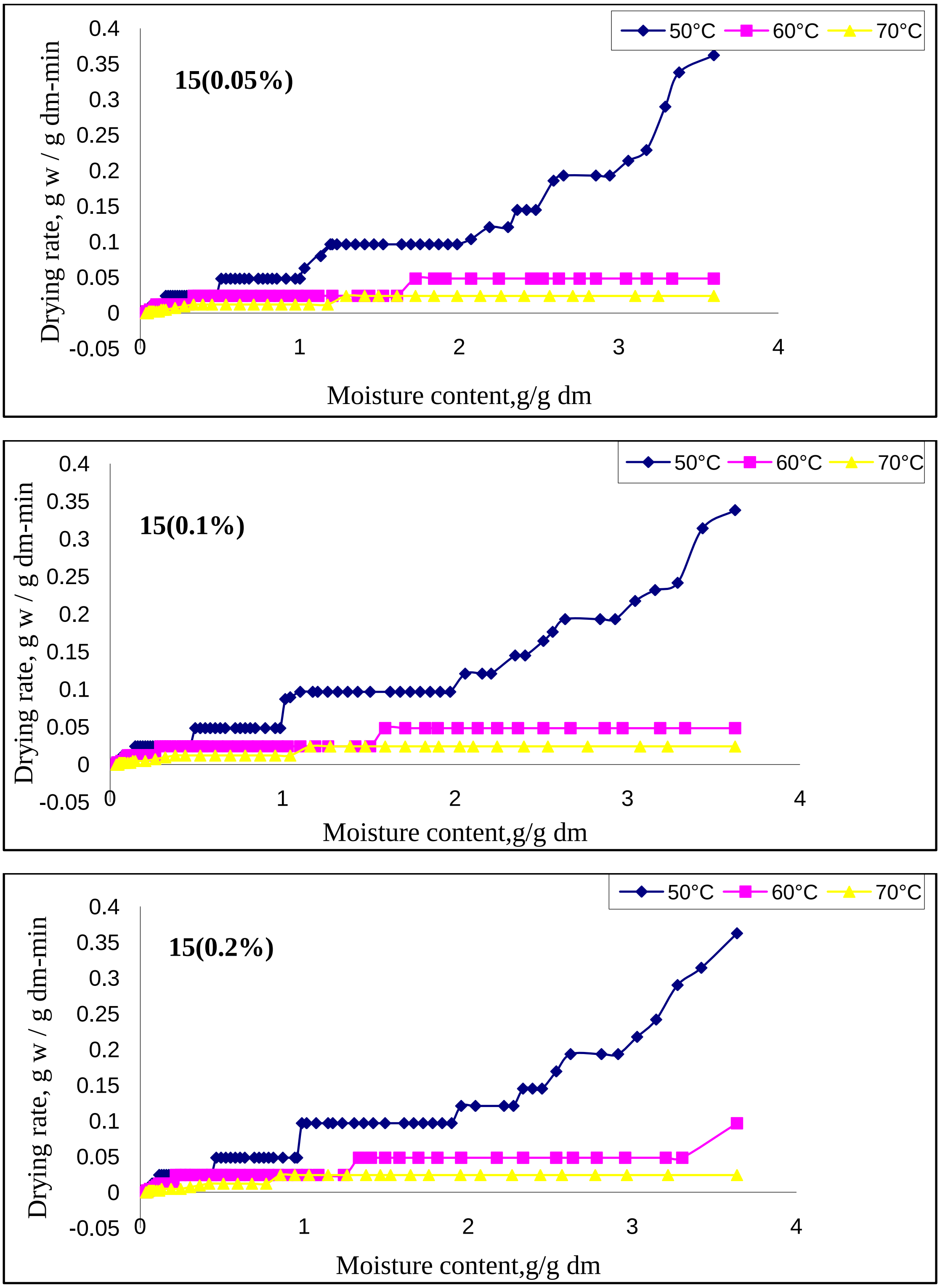

Fig.4.15 Variation of drying rate with moisture content of turmeric sample for 15 min curing / boiling time and at three different concentrations of sodium bicarbonate percent

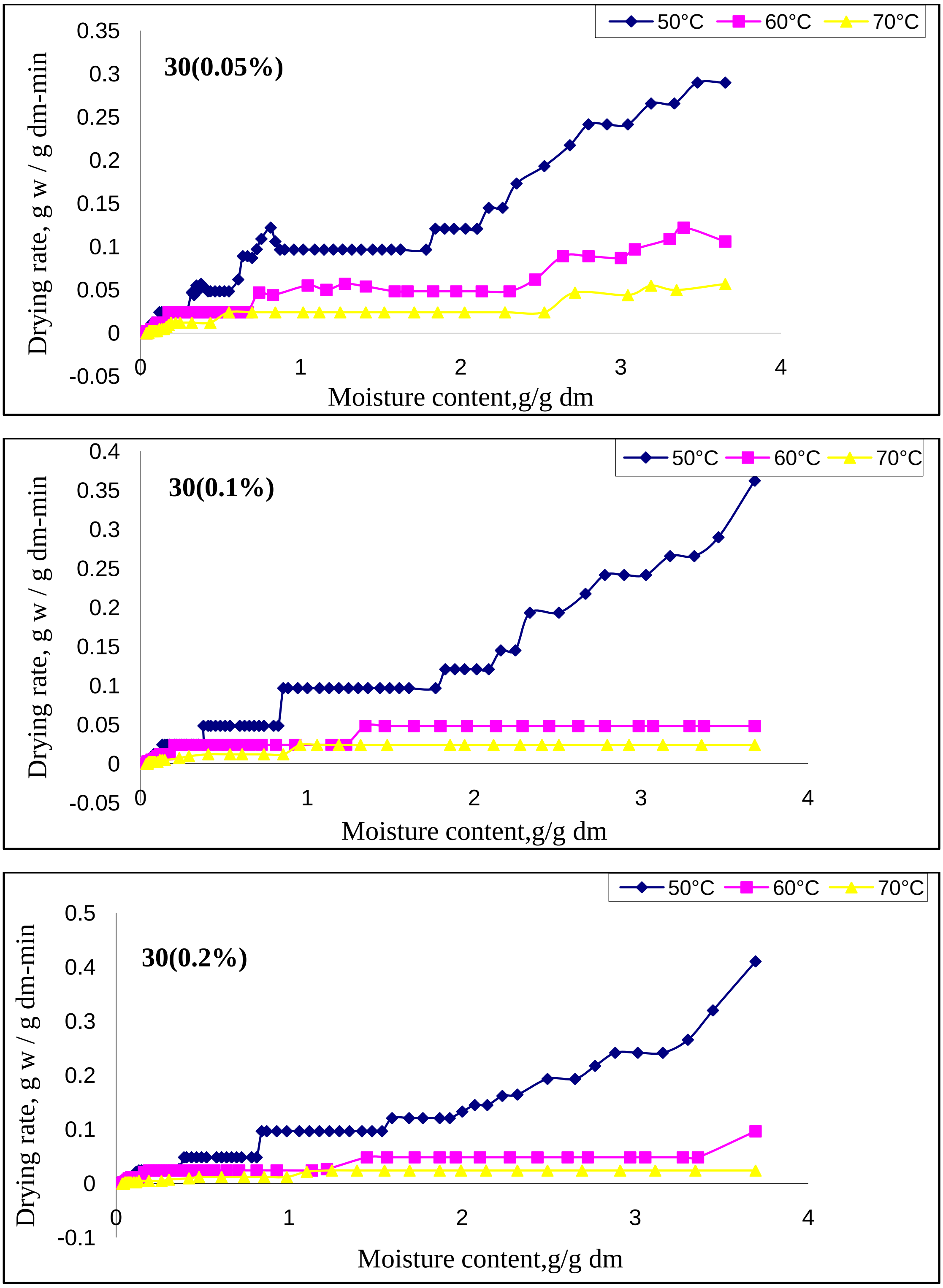

Fig. 4.16 Variation of drying rate with moisture content of turmeric sample for 30 min curing / boiling time and at three different concentrations of sodium bicarbonate percent

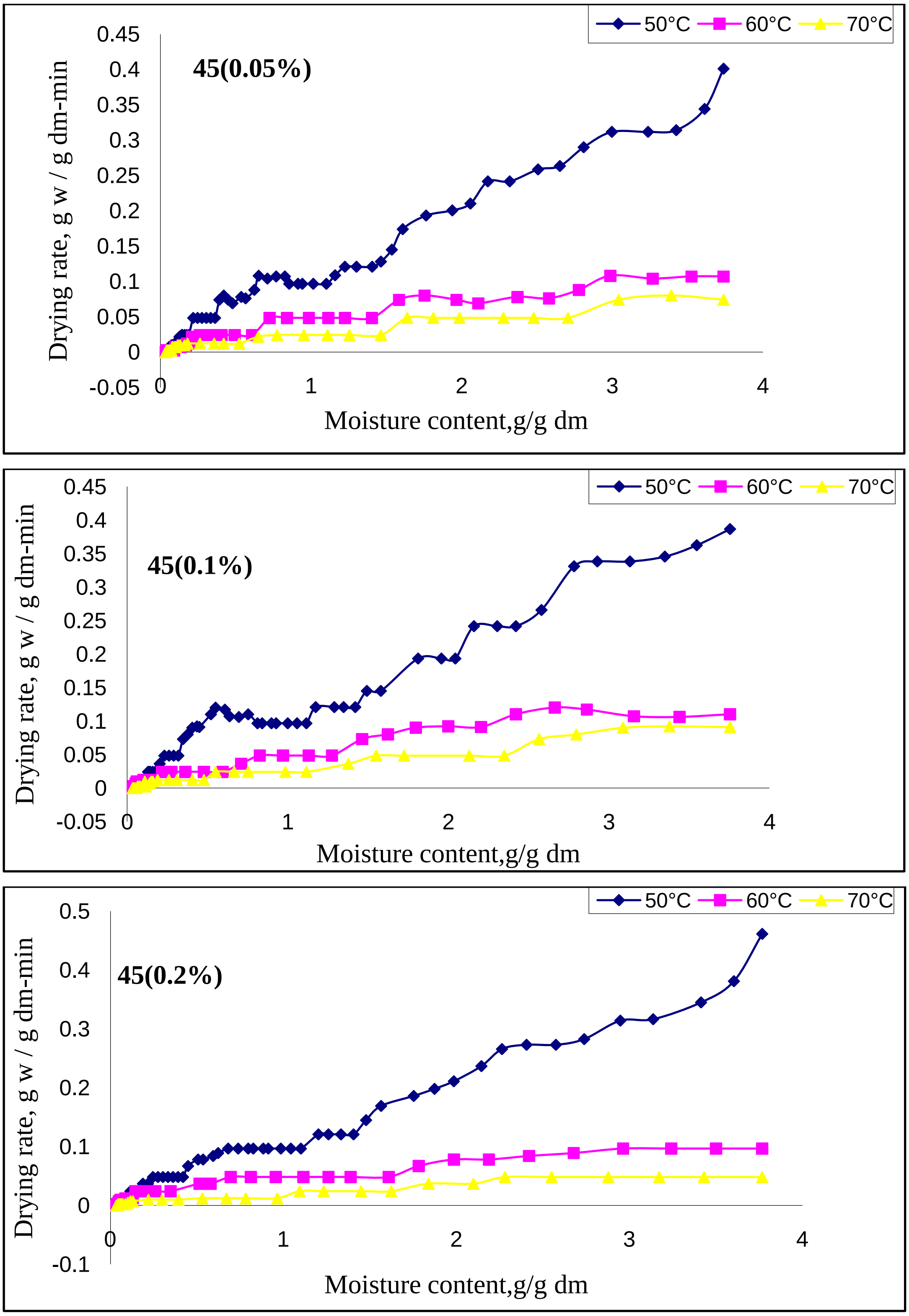

Fig. 4.17 Variation of drying rate with moisture content of turmeric sample for 45 min curing / boiling time and at three different concentrations of sodium bicarbonate percent

For the turmeric sample boiled for 30 min with 0.1 and 0.2 percent of sodium bicarbonate the drying rate of 0.36 and 0.41 g water/g dry matter-min was observed respectively for 50°C drying air temperature. For drying air temperature of 60°C and 70°C, the drying rate of 0.50 and 0.53 g water/g dry matter-min was observed for 0.1 percent sodium bicarbonate respectively.

Also for the drying air temperature of 60°C and 70°C, the drying rate of 0.55 and 0.57 g water/g dry matter-min was observed for 0.2 percent sodium bicarbonate respectively.

C. For 45 minutes of curing time

The effect of drying temperature (50, 60 and 70°C) on drying rate of samples which was boiled for 45 min at three different concentration of sodium bicarbonate (0.05, 0.1 and 0.2%) has been presented in Fig. 4.17.

It may be observed from the Fig. 4.9 that the constant rate period of drying was totally absent throughout the drying process and complete drying took place in the falling rate period for all the experiments. Initial drying rate of 0.21 g water/g dry matter-min was observed for samples dried in tray dryer at 50°C having 0.05 percent of sodium bicarbonate and this rate was reduced continuously during 71 h of drying time, whereas initial drying rate for turmeric samples dried in tray dryer at 60 and 70°C drying air temperature with 0.05 percent sodium bicarbonate was found to be 0.35 and 0.57 g water/g dry matter-min, respectively.

For the turmeric sample boiled for 45 min with 0.1 and 0.2 percent of sodium bicarbonate the drying rate was 0.34 and 0.27 g water/g dry matter-min was observed for 50°C drying air temperature respectively. For drying air temperature of 60°C and 70°C, the drying rate of 0.52 and 0.65 g water/g dry matter-min was observed for 0.1 percent sodium bicarbonate respectively.

Also for drying air temperature of 60°C and 70°C, the drying rate of 0.44 and 0.56 g water/g dry matter-min was observed for 0.2 percent sodium bicarbonate respectively.

The drying rate data were statistically analysed and regression equation of second order in following form was predicted.

$Y = aX^2 + bX + c$

Where Y is the Drying rate (g water/g dry matter-min), a, b, c are constants and X is the moisture content (g water/dry matter). The values of regression coefficient (a, b and c) and coefficient of correlation values have been presented in Table 4.2. The coefficient of correlation was more than 0.94 for all the experimental conditions, which revealed the good correlation between the predicted and observed data. Similar trend was also observed by research workers for different food products such as for mushroom by Murumlkar *et al.*(2006) and for onion by Revaskar *et al.* (2005).

Table 4.2 Predicted equations of drying rate of turmeric rhizome samples under various treatments and drying temperature

S. No.	Curing/boiling Time (min)	Sodium bicarbonate (%)	Drying Temperature (°C)	Equation predicted	R^2
1	15	0.05	50	$y = 0.0157x^2 + 0.0262x + 0.0113$	0.951
2	15	0.05	60	$y = -0.0043 x^2 + 0.0276x + 0.0047$	0.893
3	15	0.05	70	$y = -0.0036 x^2 + 0.0186x + 0.0013$	0.936
4	15	0.10	50	$y = 0.0113 x^2 + 0.0369x + 0.0097$	0.961
5	15	0.10	60	$y = -0.0051 x^2 + 0.0302x + 0.0046$	0.895
6	15	0.10	70	$y = -0.004 x^2 + 0.0199x + 0.001$	0.948
7	15	0.20	50	$y = 0.0135 x^2 + 0.0327x + 0.0118$	0.952
8	15	0.20	60	$y = -0.0037 x^2 + 0.0286x + 0.0058$	0.835
9	15	0.20	70	$y = -0.005 x^2 + 0.0229x + 0.0008$	0.939
10	30	0.05	50	$y = 0.0028 x^2 + 0.0649x + 0.012$	0.938
11	30	0.05	60	$y = -0.0005 x^2 + 0.0297x + 0.007$	0.915

S. No.	Curing/boiling Time (min)	Sodium bicarbonate (%)	Drying Temperature (°C)	Equation predicted	R^2
12	30	0.05	70	$y = -0.0003 x^2 + 0.0146x + 0.0038$	0.882
13	30	0.10	50	$y = 0.0094 x^2 + 0.0505x + 0.009$	0.967
14	30	0.10	60	$y = -0.0068 x^2 + 0.0356x + 0.0043$	0.905
15	30	0.10	70	$y = -0.0044 x^2 + 0.0213x + 0.0011$	0.945
16	30	0.20	50	$y = 0.0108 x^2 + 0.0484x + 0.01$	0.964
17	30	0.20	60	$y = -0.0032 x^2 + 0.0265x + 0.0067$	0.835
18	30	0.20	70	$y = -0.0039 x^2 + 0.0201x + 0.0007$	0.965
19	45	0.05	50	$y = -0.0026 x^2 + 0.1059x + 0.0062$	0.980
20	45	0.05	60	$y = -0.0055 x^2 + 0.0481x + 0.0023$	0.971
21	45	0.05	70	$y = -0.0006 x^2 + 0.0227x + 0.0028$	0.956
22	45	0.10	50	$y = -0.0004 x^2 + 0.1025x + 0.01$	0.963
23	45	0.10	60	$y = -0.0081 x^2 + 0.0606x + 0.0013$	0.978
24	45	0.10	70	$y = -0.0003 x^2 + 0.0264x + 0.002$	0.970
25	45	0.20	50	$y = 0.0029 x^2 + 0.0969x + 0.0072$	0.984
26	45	0.20	60	$y = -0.006 x^2 + 0.0472x + 0.005$	0.965
27	45	0.20	70	$y = -0.0023 x^2 + 0.0221x + 0.0008$	0.963

4.2.1.3 Moisture diffusivity of turmeric sample

The moisture loss data during air drying were analysed and moisture ratios at various time intervals were determined. The data of moisture ratio (MR) and natural log of moisture ratio [ln (MR)] has been presented in Appendix D.

The variation in ln (MR) with drying time for various parameters; curing/ boiling time, sodium bicarbonate percent and drying air temperature of the turmeric have been presented in Fig. 4.18 to 4.20. The variation in ln (MR) with drying time for each case was found to be linear with inverse slope. The slope became steeper with increase in drying air temperature. Moisture diffusivities were calculated from the slopes of these straight lines (Maskan *et al.* 2002; Doymaz, 2004). The moisture diffusivity value of food material was affected by moisture content as well as temperature. At lower level of moisture content the diffusivity was less than that of high moisture content. Also it was observed that moisture diffusivity increased with drying air temperature which is in accordance of the results reported by Rahman and Lamb (1991) and Pokharkar and Prasad (1998). The moisture diffusivity varied in the range of 2.69 to 4.59 $\times 10^{-09}$ m^2/s and 2.93 to 7.99×10^{-09} m^2/s during convective drying for various parameters; curing/ boiling time (15, 30 & 45 min), sodium bicarbonate (0.05, 0.1 & 0.2 percent) and drying air temperature (50, 60 & 70°C). These values are within the general range of 10^{-08} to 10^{-12} m^2/s for drying of food materials (McMinn and Magee, 1999).

The values of diffusivity with coefficients of correlation, R^2 have been presented in Table 4.3.

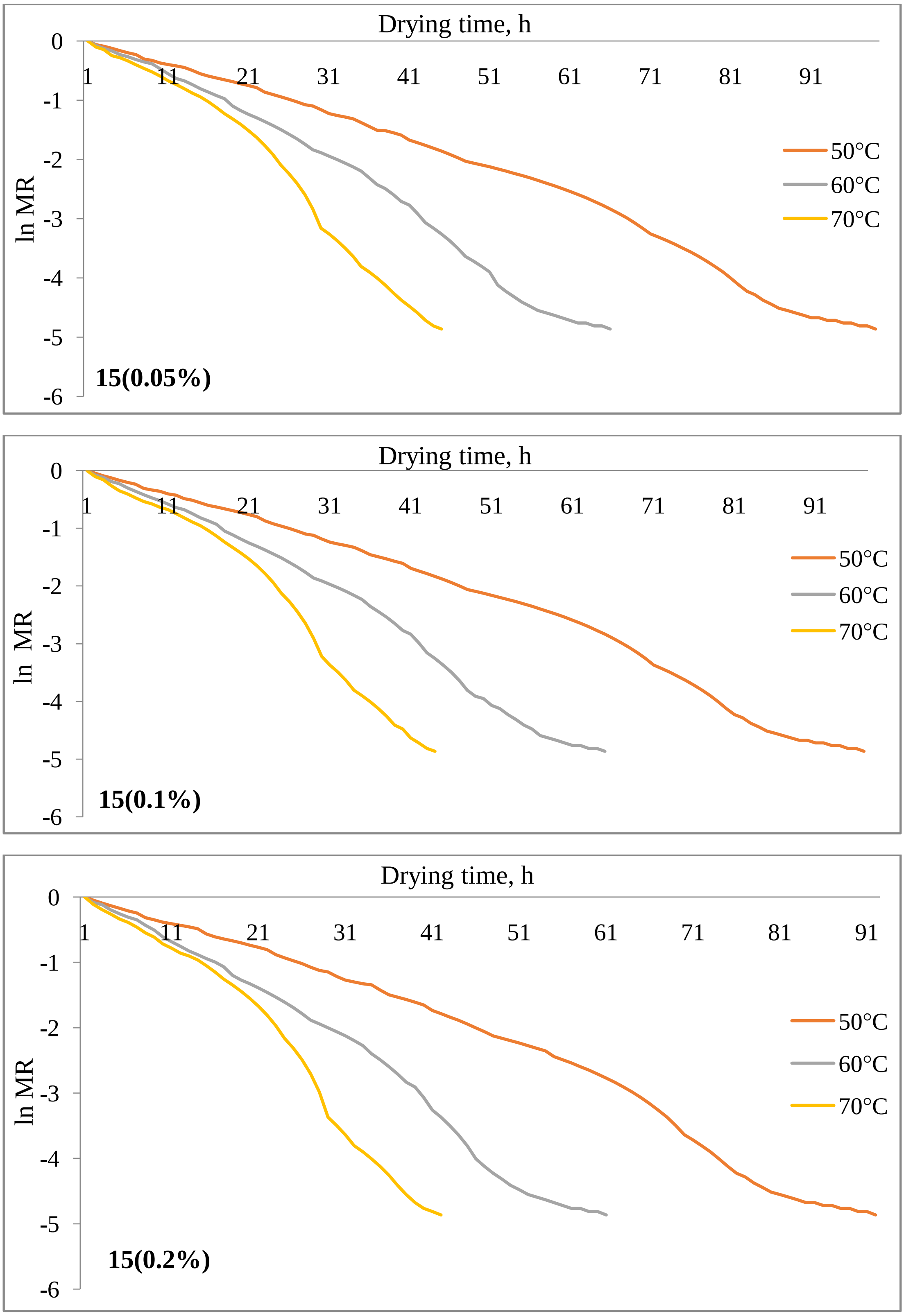

Fig.4.18 Variation of ln MR with drying time of turmeric sample for 15 min of boiling time and at three different concentrations of sodium bicarbonate

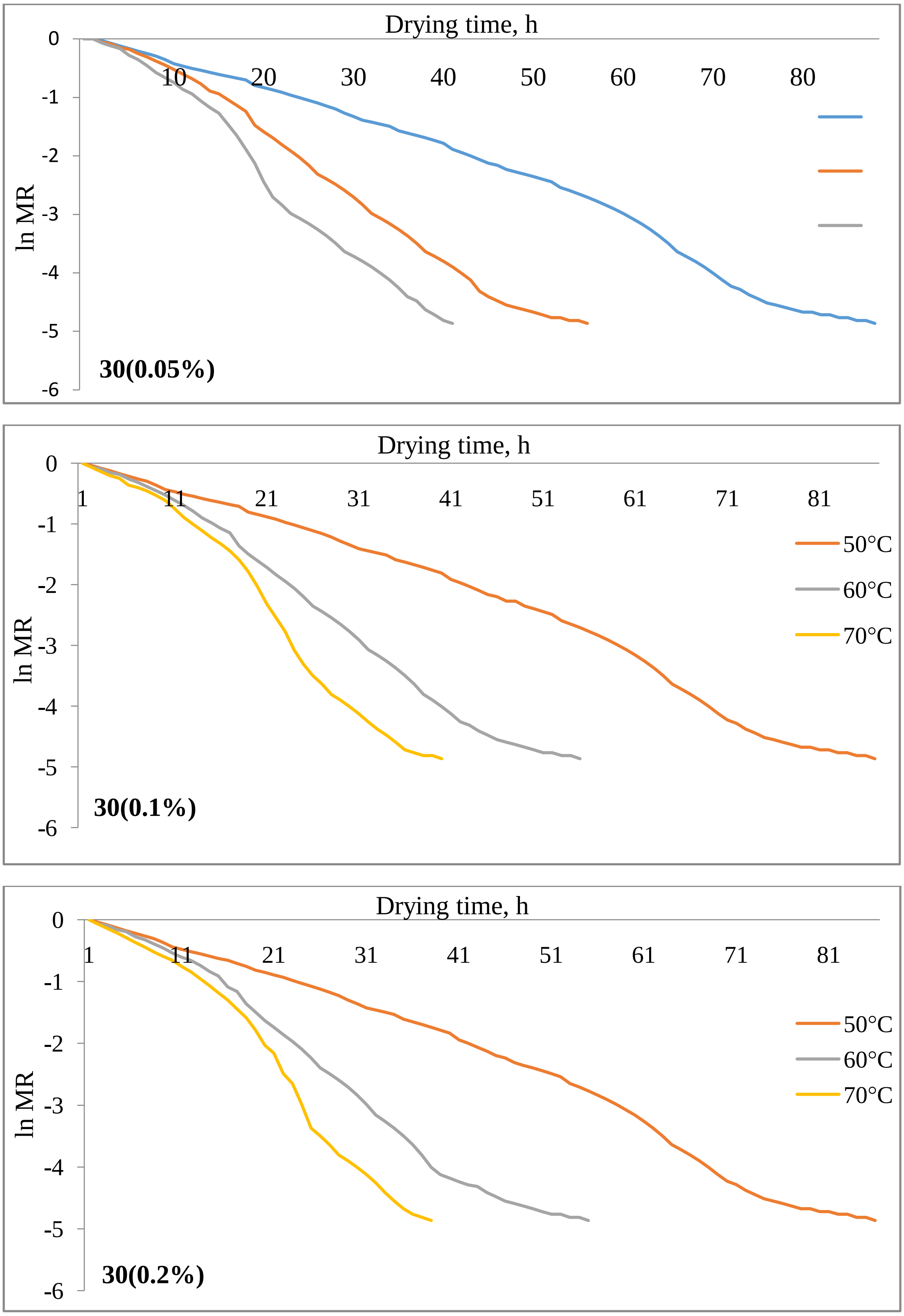

Fig.4.19 Variation of ln MR with drying time of turmeric sample for 30 min of boiling time and at three different concentrations of sodium bicarbonate

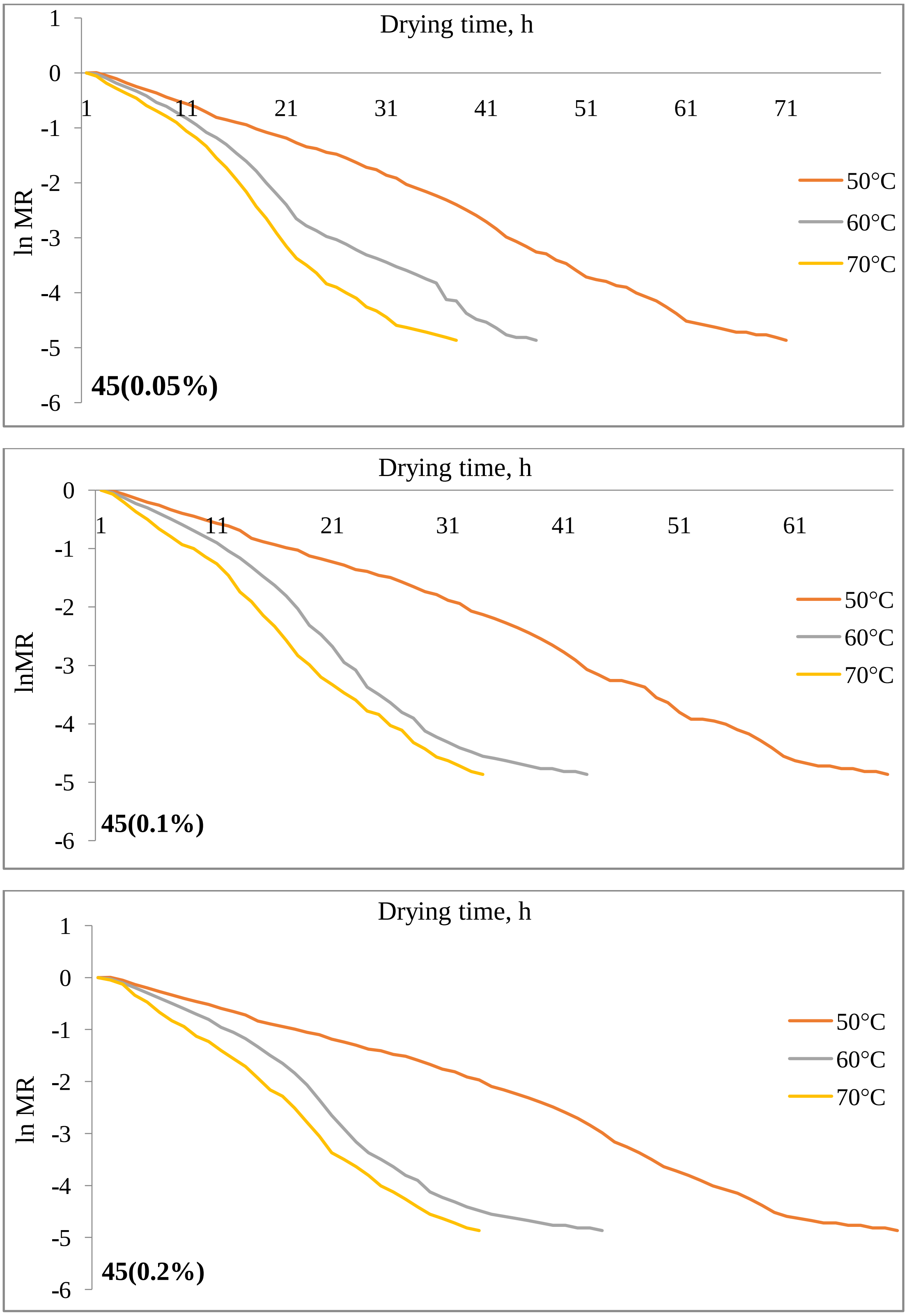

Fig.4.20 Variation of ln MR with drying time of turmeric sample for 45 min of boiling time and at three different concentrations of sodium bicarbonate

Table 4.3 Moisture diffusivity values of turmeric during convective drying under various treatments and drying air temperature

S. No.	Curing/boiling Time (min)	Sodium bicarbonate (%)	Drying Temperature (°C)	Diffusivity (m2 /s)	R^2
1	15	0.05	50	3.22×10^{-10}	0.970
2	15	0.05	60	3.42×10^{-10}	0.976
3	15	0.05	70	4.12×10^{-10}	0.987
4	15	0.10	50	3.22×10^{-10}	0.970
5	15	0.10	60	3.42×10^{-10}	0.976
6	15	0.10	70	4.12×10^{-10}	0.987
7	15	0.20	50	3.22×10^{-10}	0.970
8	15	0.20	60	3.42×10^{-10}	0.976
9	15	0.20	70	4.12×10^{-10}	0.987
10	30	0.05	50	3.22×10^{-10}	0.970
11	30	0.05	60	3.42×10^{-10}	0.976
12	30	0.05	70	4.12×10^{-10}	0.987
13	30	0.10	50	3.22×10^{-10}	0.970
14	30	0.10	60	3.42×10^{-10}	0.976
15	30	0.10	70	4.12×10^{-10}	0.987
16	30	0.20	50	3.22×10^{-10}	0.970
17	30	0.20	60	3.42×10^{-10}	0.976
18	30	0.20	70	4.12×10^{-10}	0.987
19	45	0.05	50	3.22×10^{-10}	0.970
20	45	0.05	60	3.42×10^{-10}	0.976
21	45	0.05	70	4.12×10^{-10}	0.987
22	45	0.10	50	3.22×10^{-10}	0.970
23	45	0.10	60	3.42×10^{-10}	0.976
24	45	0.10	70	4.12×10^{-10}	0.987
25	45	0.20	50	3.22×10^{-10}	0.970
26	45	0.20	60	3.42×10^{-10}	0.976
27	45	0.20	70	4.12×10^{-10}	0.987

4.2.1.4 Quality evaluation of dehydrated turmeric sample

The quality of dehydrated turmeric samples per-treated with different combination of boiling time (15, 30 and 45 min) and sodium bicarbonate percent (0.05, 0.1 and 0.2) were further evaluated for their quality aspects such as water activity, curcumin content and oleoresin content.

Table 4.4 Water activity (a_w) of dehydrated turmeric sample

S. No.	Curing/boiling Time (min)	Sodium bicarbonate (%)	Drying Temperature (°C)	Water Activity (a_w)
1	15	0.05	50	0.630
2	15	0.05	60	0.600
3	15	0.05	70	0.587
4	15	0.10	50	0.640
5	15	0.10	60	0.613
6	15	0.10	70	0.603
7	15	0.20	50	0.630
8	15	0.20	60	0.613
9	15	0.20	70	0.610
10	30	0.05	50	0.617
11	30	0.05	60	0.600
12	30	0.05	70	0.577
13	30	0.10	50	0.610
14	30	0.10	60	0.593
15	30	0.10	70	0.590
16	30	0.20	50	0.603
17	30	0.20	60	0.577
18	30	0.20	70	0.570
19	45	0.05	50	0.623
20	45	0.05	60	0.593
21	45	0.05	70	0.563
22	45	0.10	50	0.593
23	45	0.10	60	0.570
24	45	0.10	70	0.553
25	45	0.20	50	0.590
26	45	0.20	60	0.557
27	45	0.20	70	0.540

A. Water activity

Water activity was determined as a measure of storage stability using a Pawkit water activity meter at room temperature for all samples. Water activity is related to moisture content and all samples in this study were set to reach safe level of final moisture content, so the results did not show any difference in water activity (Table 4.4). The water activity of all samples were around 0.35- 0.64 which is recommended to avoid microbial growth and enzymatic reactions (Barbosa-Canovas and Vega-Mercado, 1996).

Analysis of variance was carried out to study the effect of process variables on the water activity and is given in Table 4.5. It can be observed from the Table 4.5 that all the parameters i.e. curing time (min), sodium bicarbonate (%) and drying air temperature (°C) had significant effect on water activity. Also the interaction of any two parameters out of three had significant effect on water activity at 1% level.

Table 4.5 Analysis of variance for the effect of process variables on the water activity (a_w)

SOURCE	Df	Sum of Square	Mean Square	F -Ratio
MAIN EFFECTS				
A: Boiling time	2	0.01972	0.00986	106.4933 **
B: Sodium bicarbonate	2	0.00182	0.00091	9.8533**
C: Drying temperature	2	0.02017	0.01008	108.8933**
INTERACTIONS				
A × B	4	0.00495	0.00124	13.3733**
A × C	4	0.00101	0.00025	2.7333**
B × C	4	0.00078	0.00019	2.0933NS
A × B × C	8	0.00054	0.00007	0.7233NS
ERROR	54	0.00500	0.00009	

** Significant at 1%, CV = 1.62

B. Curcumin content

It is the important quality parameters to decide the commercial value of turmeric in local and international market. The curcumin content of turmeric was affected by the various process parameters during processing. Table 4.6 show the effect of different process parameters on the value of curcumin content.

Table 4.6 Curcumin content of dehydrated turmeric sample

S. No.	Curing/boiling Time (min)	Sodium bicarbonate (%)	Drying Temperature (°C)	Curcumin content (%)
1	15	0.05	50	3.200
2	15	0.05	60	3.150
3	15	0.05	70	3.040
4	15	0.10	50	3.280
5	15	0.10	60	3.223
6	15	0.10	70	3.200
7	15	0.20	50	3.150
8	15	0.20	60	3.110
9	15	0.20	70	3.100
10	30	0.05	50	2.953
11	30	0.05	60	2.887
12	30	0.05	70	2.820
13	30	0.10	50	3.053
14	30	0.10	60	3.017
15	30	0.10	70	3.003
16	30	0.20	50	2.930
17	30	0.20	60	2.903
18	30	0.20	70	2.893
19	45	0.05	50	2.973
20	45	0.05	60	2.967
21	45	0.05	70	2.913
22	45	0.10	50	2.983
23	45	0.10	60	2.980
24	45	0.10	70	2.940
25	45	0.20	50	2.980
26	45	0.20	60	2.960
27	45	0.20	70	2.910

The value of curcumin content varies from 2.91 – 3.20 percent for all the samples with different pre-treatments i.e. curing time (min), sodium bicarbonate (%) and drying air temperature (°C). It was observed that in all the samples with different concentration of sodium bicarbonate the value of curcumin content decreases with increased in drying air temperature. The higher value of curcumin content was observed for the samples dried in 50°C air temperature.

The analysis of variance was carried out to study the effect of process variables on the curcumin content and is given in Table 4.7. It can be observed from the Table 4.7 that all the parameters i.e. curing time (min), sodium bicarbonate (%) and drying air temperature (°C) had significant effect on value of curcumin content. Also the interaction of any two parameters out of three and also the interaction of all three parameters had significant effect on curcumin content at 1% level.

Table 4.7 Analysis of variance for the effect of process variables on the curcumin content

SOURCE	Df	Sum of Square	Mean Square	F -Ratio
MAIN EFFECTSEF!				
A: Boiling time	2	0.82279	0.41139	1948.7018**
B: Sodium bicarbonate	2	0.12854	0.06427	304.4386**
C: Drying temperature	2	0.07810	0.03905	184.9649**
INTERACTIONS				
A × B	4	0.04405	0.01101	52.1667**
A × C	4	0.00559	0.00140	6.6140**
B × C	4	0.01363	0.00341	16.1404**
A × B × C	8	0.00787	0.00098	4.6579**
ERROR	54	0.01140	0.00021	

** Significant at 1%, CV = 0.48

C. Oleoresin content

Oleoresin is a flavor profile extracted from the agricultural produce. In the food and beverage industries, oleoresin extracted from spices was more desirable than the fresh or dried spices because of its complete flavor, consistency, and measurable nature. However, oleoresin was susceptible to degradation due to air, light, water, as well as high temperatures and it even has a short shelf-life if stored inappropriately. In case of turmeric, the variation in oil content was depending on the turmeric varieties, age of harvest and extraction conditions (Yuliani *et al*., 1991).

The value of oleoresin content varies from 1.96 – 2.39 percent for all the samples with different pre-treatments i.e. curing time (min), sodium bicarbonate (%) and drying air temperature (°C) as given in Table 4.8.

It was observed that in all the samples with different concentration of sodium bicarbonate the value of oleoresin content decreases with the increased in drying air temperature. The higher value of curcumin content (2.01-2.39 percent) was observed for the samples dried in 50°C.

Table 4.8 Oleoresin content of dehydrated turmeric sample

S. No.	Curing/boiling Time (min)	Sodium bicarbonate (%)	Drying Temperature (°C)	Oleoresin content (%)
1	15	0.05	50	2.214
2	15	0.05	60	2.199
3	15	0.05	70	2.187
4	15	0.10	50	2.398
5	15	0.10	60	2.315
6	15	0.10	70	2.288
7	15	0.20	50	2.385
8	15	0.20	60	2.272
9	15	0.20	70	2.209
10	30	0.05	50	2.008
11	30	0.05	60	1.998
12	30	0.05	70	1.982
13	30	0.10	50	2.150
14	30	0.10	60	2.096
15	30	0.10	70	2.004

S. No.	Curing/boiling Time (min)	Sodium bicarbonate (%)	Drying Temperature (°C)	Oleoresin content (%)
16	30	0.20	50	2.167
17	30	0.20	60	2.128
18	30	0.20	70	2.099
19	45	0.05	50	2.011
20	45	0.05	60	1.977
21	45	0.05	70	1.963
22	45	0.10	50	2.135
23	45	0.10	60	2.121
24	45	0.10	70	2.086
25	45	0.20	50	2.154
26	45	0.20	60	2.130
27	45	0.20	70	2.093

The analysis of variance was carried out to study the effect of process variables on the oleoresin content and is given in Table 4.9. It can be observed from the Table 4.9 that all the parameters i.e. curing time (min), sodium bicarbonate (%) and drying air temperature (°C) had significant effect on value of oleoresin content. Also the interaction of any two parameters out of three and also the interaction of all three parameters had significant effect on oleoresin content at 1% level.

Table 4.9 Analysis of variance for the effect of process variables on the Oleoresin content

SOURCE	DF	Sum of Square	Mean Square	F –Ratio
MAIN EFFECTS				
A: Boiling time	2	0.82279	0.41139	14600.1216**
B: Sodium bicarbonate	2	0.12854	0.06427	5153.0064**
C: Drying temperature	2	0.07810	0.03905	1693.8616**
INTERACTIONS				
AXB	4	0.04405	0.01101	219.9399**
AXC	4	0.00559	0.00140	79.9451**
BXC	4	0.01363	0.00341	142.7745**
AXBXC	8	0.00787	0.00098	78.6582**
ERROR	54	0.01140	0.00021	

** Significant at 1%, CV = 0.23

4.3 Time Reduction Technology for Conversion of Farm Fresh Turmeric Rhizomes Directly Into Dry Concentrate/Powder

In time reduction technology concept, experiment was planned to convert farm fresh turmeric rhizomes directly into powder by skipping curing/boiling process so that the total processing time will reduced and at the same time quality of dried turmeric powder was maintained. In this attempt two methods are tried as given below:

1. Fresh turmeric sample directly cut into 1, 2 & 3 cm slices and dried in tray dryer
2. Fresh turmeric sample cut into 1 and 2 cm slices and treated in vacuum oven for 1 hour and further drying in a tray dryer.

4.3.1 Convective drying of non-curing turmeric sample (cut sample)

In this part, the result of convective drying has been presented. The fresh sample of turmeric rhizomes were cut into slices of 1 and 2 cm and were directly placed into tray dryer for drying at temperature of 50, 60 and 70°C with constant air velocity of 1m/s. In this method turmeric sample were not go under curing/boiling process.

A. Effect of moisture content on time

Fig. 4.13 shows the variation in moisture content with time for non-boiled turmeric samples. In general it was found that the drying time was decreased with the decrease in sample thickness i.e. from 3 to 1 cm and also the drying time were decreased with the increase in drying air temperature i.e. from 50 to 70°C. The details of drying time (h) required for both the size sample with three different drying air temperature is given in the Table. 4.10.

Table 4.10 Drying time of cut sample turmeric rhizome and drying temperature

S. No.	Cutting sample	Drying Temperature (°C)	Drying time (h)
1.	1	50	66
2.	1	60	58
3.	1	70	52
4.	2	50	94
5.	2	60	80
6.	2	70	68
7.	3	50	136
8.	3	60	119
9.	3	70	107

B. Drying rate curve

Fig. 4.21 shows the effect of drying air temperature on drying rate. In general, it was found that the complete drying of cut sample of turmeric rhizomes was took place in the falling rate period and the constant rate period was completely absent in the tray drying carried for all samples. Also, the drying rate increased with the increase in drying temperature from 50 to 70°C and also increased with decrease in sample thickness. As thickness of sample decreased, more surface area available for the moisture removal which increases the drying rate. This resulted into substantial decrease into drying time.

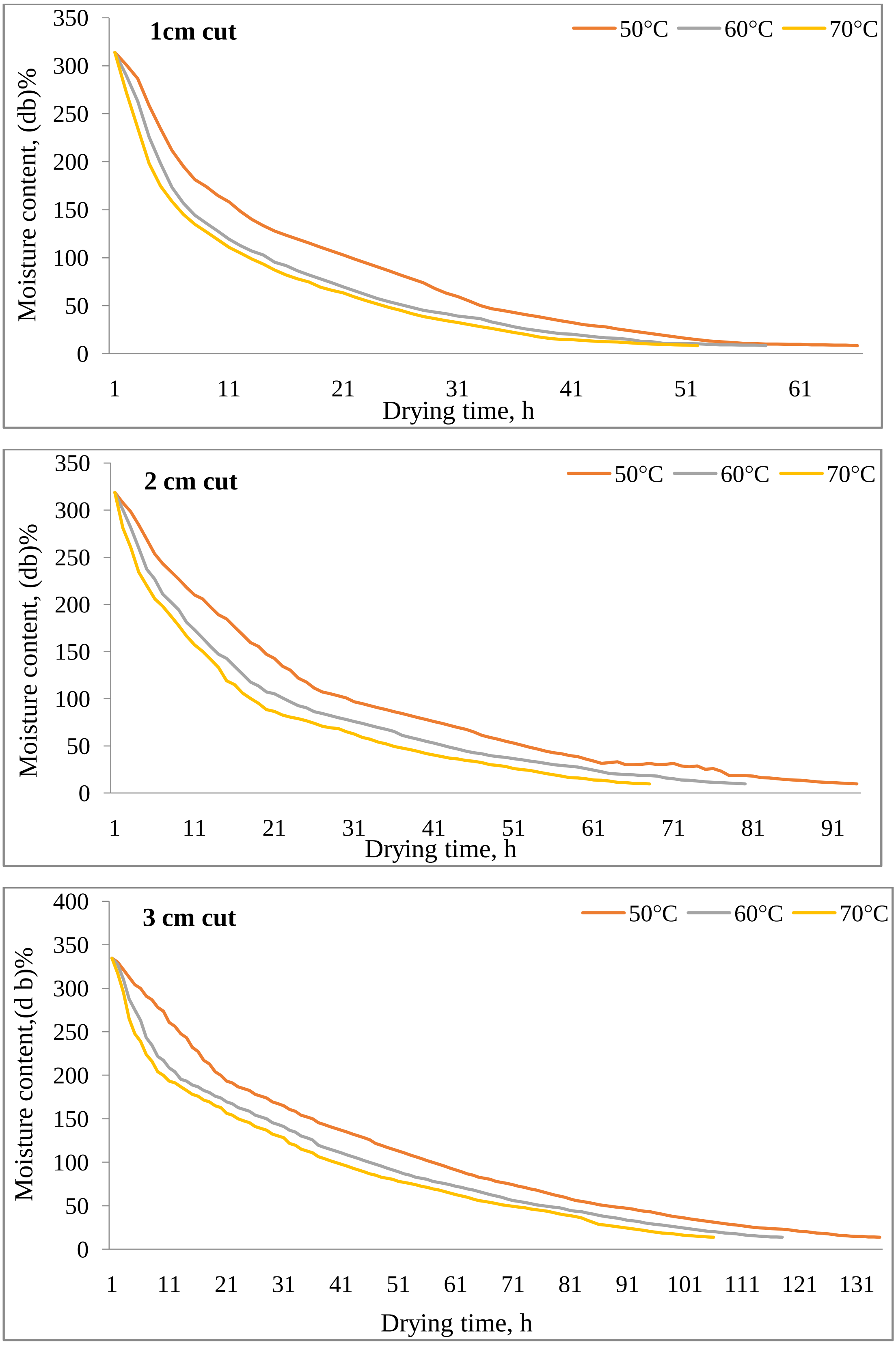

Fig. 4.21 Variation of moisture content with drying time of cut turmeric sample dried at three different air temperatures

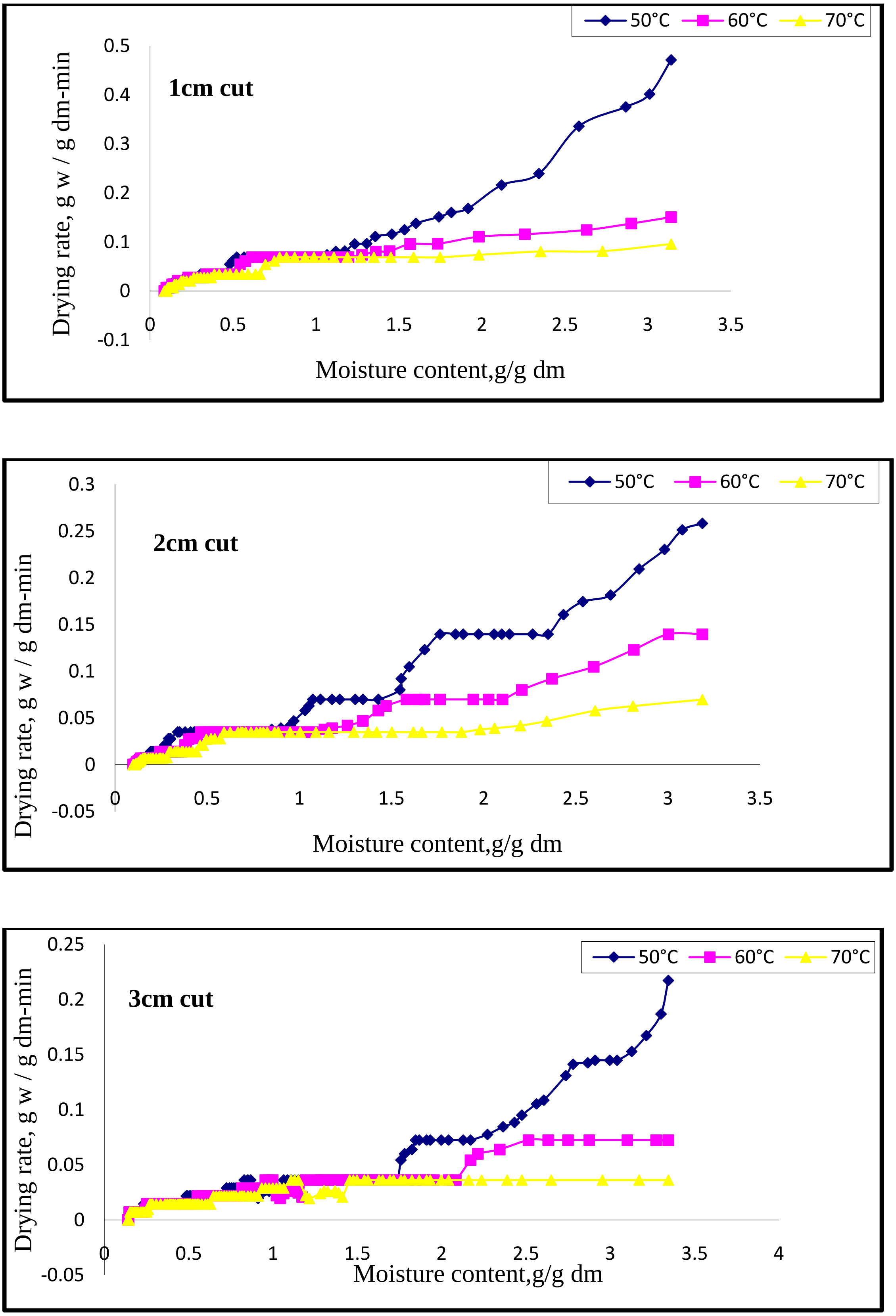

Fig. 4.22 Variation of drying rate with moisture content of cut turmeric sample dried at three different air temperatures

C. Moisture diffusivity

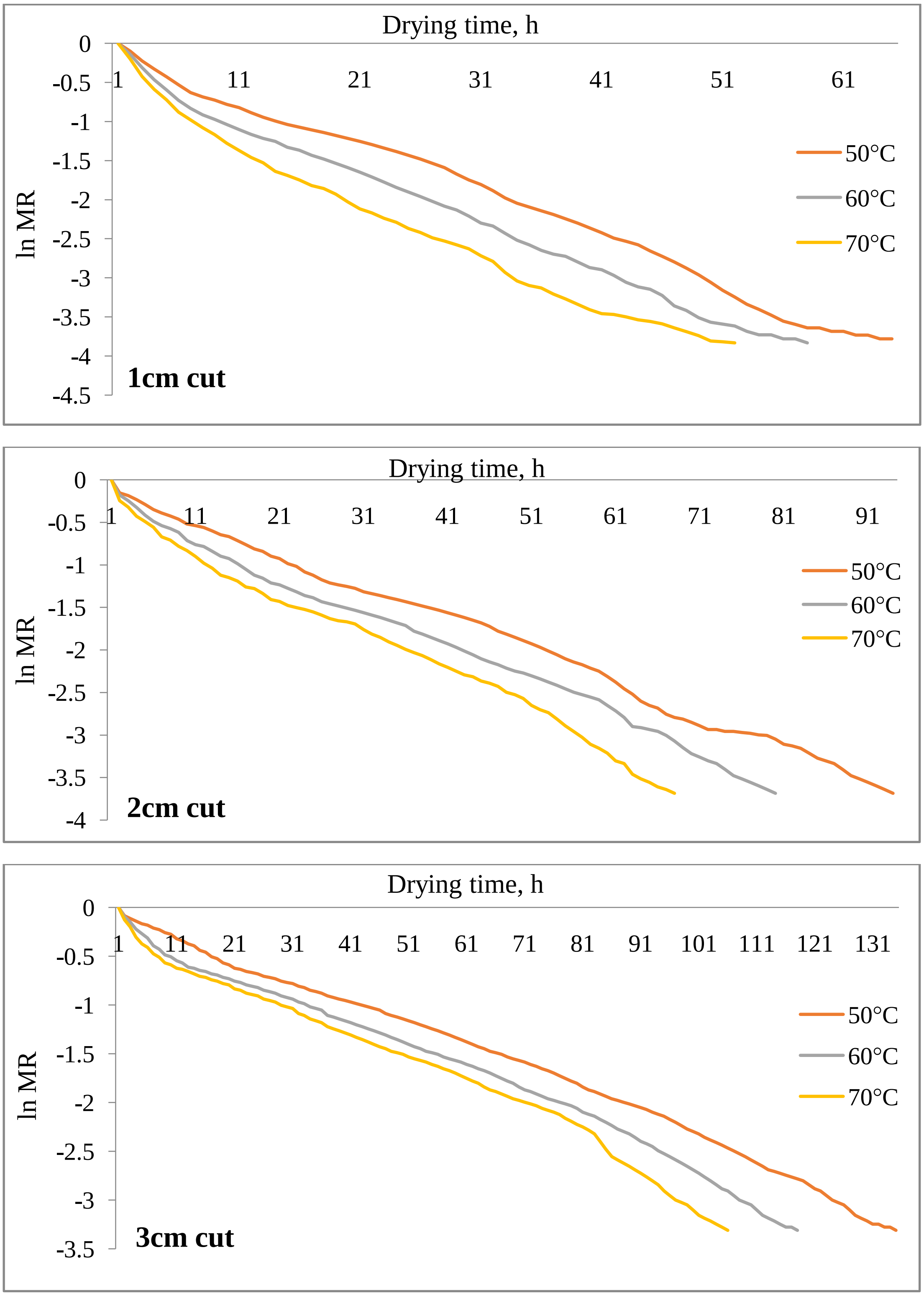

Fig. 4.23 Variation of ln MR with drying time of cut turmeric sample dried at three different air temperatures

4.3.2 Quality evaluation non-curing cut sample

A. Water activity

The water activity was related to moisture content and all samples (curing turmeric rhizomes and cutting samples) in this study were set to reach safe level of final moisture content (8.0 percent wb). The water activities of all samples were measured by using a Pawkit water activity meter at room temperature and mean value is presented in Table 4.11. The water activity ranged between 0.54 - 0.62 for all cut sample which is within safe limit to avoid microbial growth and enzymatic reactions (Barbosa-Canovas and Vega-Mercado, 1996).

Table 4.11 Mean value of water activity (a_w) for convective dried products

S. No.	Treatment	Water activity		
		Temperature (°C)		
		50	60	70
1	1cm cut	0.623	0.593	0.563
2	2cm cut	0.593	0.570	0.553
3	3cm cut	0.590	0.557	0.540

Table 4.12 ANOVA for the effect of convective drying temperature on water activity of turmeric powder dried cut samples

Source	DF	MS	F	S_E (m)	CD (5%)
Treatment	8	0.001151	22.195 **	0.0042	0.01
Error	18	0.000052			
Total	17.3200				

** Significant at 1% level, CV% 1.12

Analysis of variance was carried out to study the effect of size of cutting turmeric rhizome and drying temperature same has been presented in Table 4.12. The analysis shows that in main effect the cutting and drying temperature has significant effect on water activity. Also the interactions of treatments have significant effect on water activity at 1% level for cut sample.

B. Oleoresin content

Oleoresin content decreased with increasing drying temperature from 50 to 70°C in each sample. This was due to evaporation of atile oil at higher temperature. The data presented in Table 4.13 revealed that there was not much effect of temperature on oleoresin content but at the same time effect of sample cut size is noticeable i.e with the decreased in sample thickness content of oleoresin decreases.

Table 4.13 Mean of oleoresin content of dried samples

S. No.	Treatment	Oleoresin content		
		Temperature (°C)		
		50	60	70
10	1cm cut	2.174	2.143	2.118
11	2cm cut	2.497	2.365	2.293
12	3cm cut	2.898	2.852	2.842

Table 4.14 ANOVA for the effect of convective drying temperature on oleoresin of turmeric powder dried cut samples

Source	DF	MS	F	S_E (m)	CD (5%)
Treatment	8	0.390119	13194.216 **	0.0031	0.01
Error	18	0.000030			
Total	67.3430				

** Significant at 1% level, CV% 0.22

Analysis of variance was carried out to study the effect of sample size and drying air temperature as presented in Table 4.14. The analysis shows that in main effect the cutting and drying temperature has significant effect on oleoresin content at 1 % level of significance.

C. Curcumin content

The values of curcumin content for cut sample treated convective dried cut turmeric samples were ranged between 2.74 to 2.99 per cent. The values of curcumin content as present in Table 4.15 revealed that the there was not much effect of temperature rather than the size of sample. As the thickness of sample is reduced the curcumin content goes on decreasing for all the drying temperature.

Table 4.15 Mean of curcumin content of dried (powder) samples

S. No.	Treatment	curcumin content %		
		Temperature (°C)		
		50	60	70
1.	1cm cut	2.740	2.735	2.720
2.	2cm cut	2.897	2.893	2.865
3.	3cm cut	2.998	2.952	2.898

The effect of drying temperature and size of sample thickness on curcumin content would be observed by carried out analysis of variance and represented in Table 4.16. The analysis shows that the size of cutting and drying air temperature has significant effect on curcumin content. The interactions of cutting and drying temperature have significant effect on water activity at 1% level.

Table 4.16 ANOVA for the effect of convective drying temperature on curcumin of turmeric powder dried cut samples

Source	DF	MS	F	S_E (m)	CD (5%)
Treatment	8	0.016426	123.343 **	0.0067	0.02
Error	18	0.000133			
Total	79.3300				

** Significant at 1% level, CV% 0.39

4.3.3 Convective drying of vacuum treated non-curing turmeric sample (cut sample)

The drying characteristics of fresh cut turmeric rhizomes which were pre-treated with vacuum treatment (temperature of 60°C and vacuum pressure of 65psi) for 1 hour and convective drying at three different air temperature of 50, 60 and 70°C with a constant air velocity of 1.0 m/s are presented in Appendix E. The initial moisture content of fresh turmeric rhizomes is 77 percent (wb) and after 1 hr of vacuum treatment moisture reduced up to 74.85 percent (wb) and this moisture content (74.85 percent, wb) is taken as initial moisture content for convective drying. The final moisture content of convective dried turmeric sample was 8.79 percent (wb). The variation in moisture content of dehydrated turmeric samples with drying time, drying rate and effective moisture diffusivities were calculated and presented in following sections.

A. Effect of moisture content on time

The Fig. 4.24 shows a typical drying curves showing variation in moisture content (g water / g dry matter) with drying time (h) for vacuum pre-treated dehydrated cut turmeric rhizome with air temperature of 50, 60 and 70 °C for constant air velocity of 1.0 m/s. It was observed from these curves that moisture content of all turmeric samples decreases exponentially with drying time under all drying conditions. The moisture-time relationship is non-linear and the decrease in moisture is larger initially as compared to later part of drying. The drying time was longest when dried at 50°C and least when dried at 70°C drying temperature. At drying temperatures 50, 60 and 70°C the drying time was 63, 51 and 43 h for 1cm cut turmeric rhizome and 89, 72 and 60 h for 2cm cut turmeric rhizome sample respectively. That means there were about 13.21 and 19.04 per cent reduction in drying time as temperature increases from 50 to 60°C and 60 to 70ºC respectively.

This reduction in time according to kinetic theory and it states that, as temperature is increases, the energy of water molecules also increases. Hence, escaping of molecules becomes easier from the medium and faster. Similar behaviors were reported by Prabhanjan *et al.* (1995) for carrots, Moyls (1981) for apple purees drying, Salgado *et al*. (1994) for sugar beet root and sugar beet pulp and Maskan *et al*. (1998) for tarhana dough.

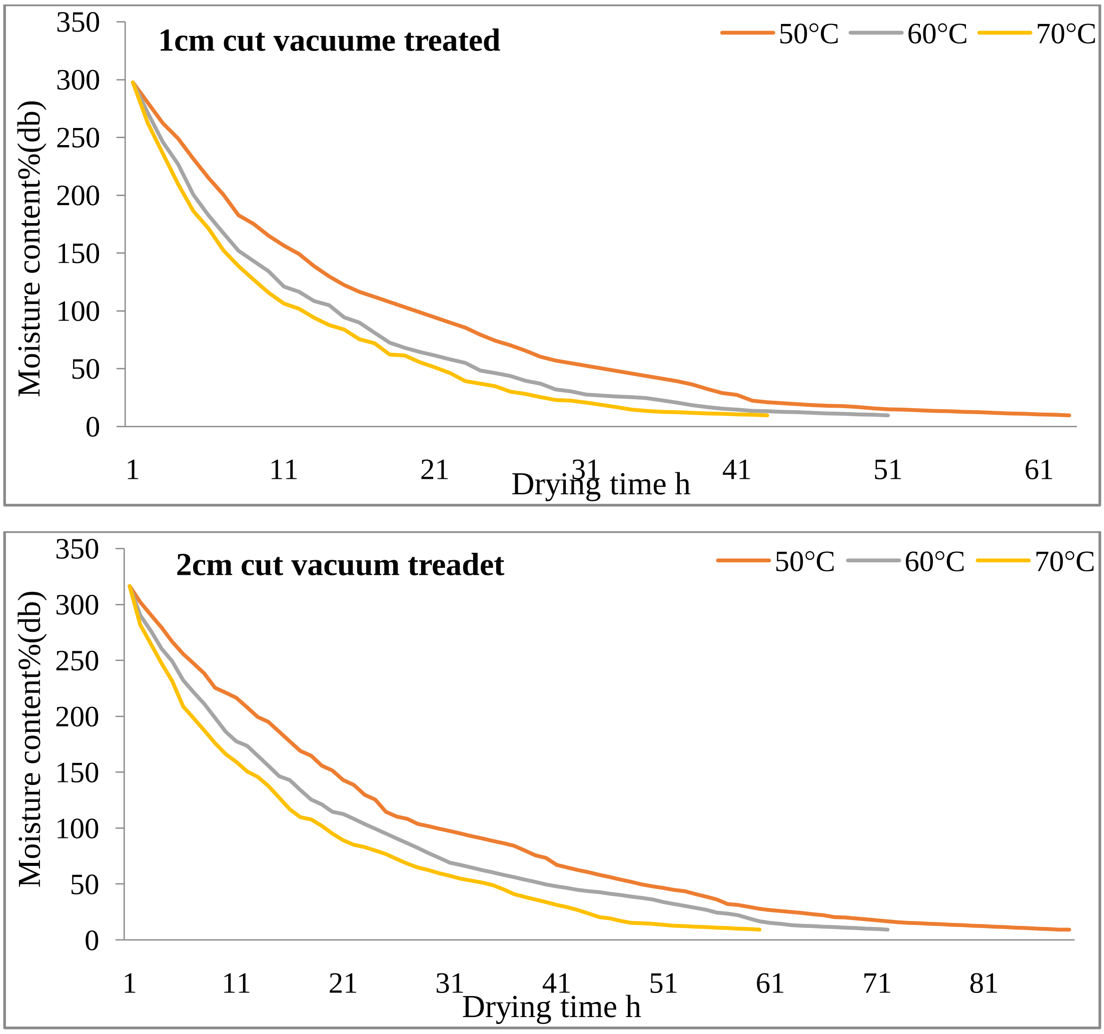

Fig. 4.24 Variation in moisture content with drying time of turmeric sample having different thickness of sample size at different drying temperature

B. Drying rate curve

The drying rate data plotted against the moisture content are presented in Fig. 4.17. In general, it was found that the complete drying of turmeric rhizome sample was took place in the falling rate period and the constant rate period was completely absent in the tray drying carried for all the samples. The drying in falling rate period indicates that, internal mass transfer has occurred by diffusion. Similar results have been reported for the drying studies on onion slices (Rapusas & Driscoll, 1995) and apricots (Doymaz, 2004). It was observed from the curves that the drying rate was higher in the initial period of drying and subsequently it was reduced with decrease in moisture content.

The initial drying rates were as high as 2.222 g water/g dry matter-min at drying temperature 70°C and as low as 1.983 g water/g dry matter-min at drying temperature 50°C for turmeric rhizome (Fig.4.25). Similarly for 1cm and 2cm turmeric cut sample, the initial drying rates were as high as 3.228 and 4.323 g water/g dry matter-min at drying temperature 70°C respectively and as low as 2.214 and 2.460 g water/g dry matter/min at drying temperature 50 °C respectively). The high drying rate at the start of drying was due to high surface moisture availability, which evaporates rapidly. Further decrease in drying rate was owed to decrease in available moisture due to low driving force and low moisture diffusion from centre to surface of the dried product.

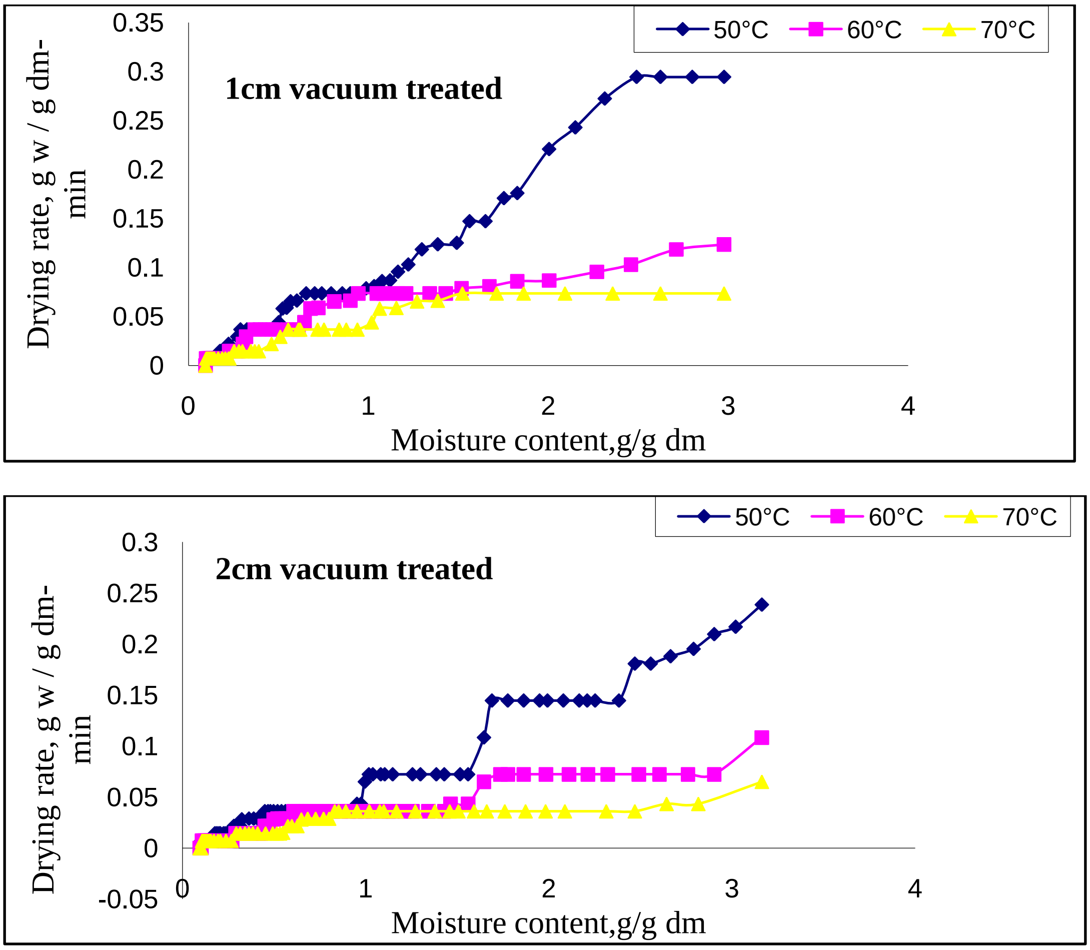

Fig. 4.25 Variation of drying rate with moisture content of cut turmeric sample dried at three different air temperatures

C. Moisture diffusivity

The moisture loss data during air drying were analyzed and moisture ratios at various time intervals were determined. The data of moisture ratio and natural log of moisture ratio are presented in Appendix E.

The variation in ln (MR) with drying time of the turmeric cut sample is presented in Fig. 4.18. The variation in ln (MR) with drying time for each case was found to be linear with inverse slope. The moisture diffusivity value of food material was affected by moisture content as well as temperature. The moisture diffusivity value ranged from 3.1450×10^{-10} to 5.2170×10^{-10} m²/s for1cm turmeric cut and 9.5439×10^{-11} to 1.6121×10^{-10} m²/s for 2 cm turmeric cut sample depending on the drying air temperature.

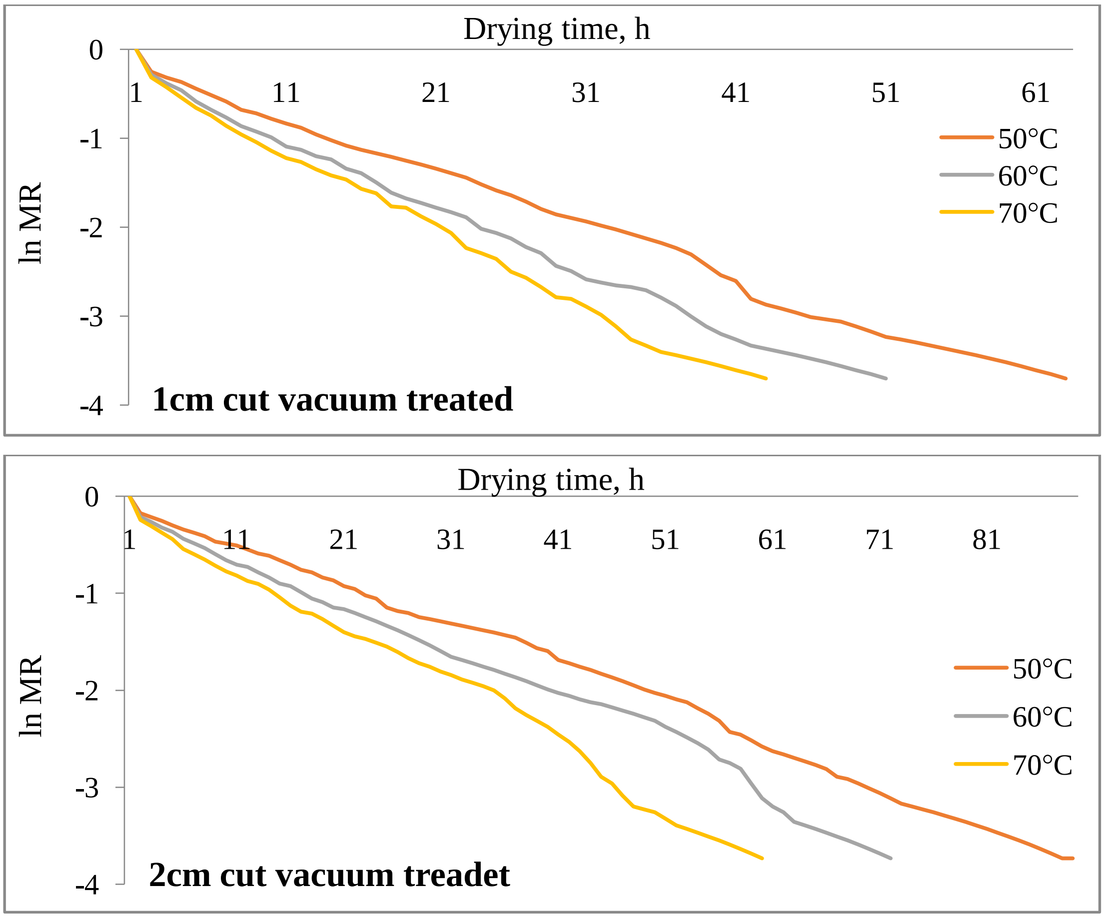

Fig. 4.26 Variation of in MR with drying time of cut turmeric sample dried at three different air temperatures.

These diffusivity values are within the general range of $10^{-10}$to 10^{-12} m²/s for drying of food materials (McMinn and Magee, 1999). The values of diffusivity with coefficients of correlation, R^2 are given in Table 4.10.

4.3.4 Quality evaluation of vacuum treated non-curing turmeric cut sample

A. Water activity

The water activities of all samples were measured by using a Pawkit water activity meter at room temperature and mean value is presented in Table 4.17. The water activity ranged between 0.543 - 0.613 for all cut sample which is within safe limit to avoid microbial growth and enzymatic reactions (Barbosa-Canovas and Vega-Mercado, 1996).

Table 4.17 Mean value of water activity (a_w) for vacuum treated dried products

S. No.	Treatment	Water activity		
		Temperature (°C)		
		50	60	70
1	1cm cut	0.613	0.583	0.553
2	2cm cut	0.583	0.560	0.543

B. Oleoresin content

The value of oleoresin content data presented in Table 4.18 which revealed that there was not much effect of temperature on oleoresin content but at the same time effect of sample cut size is noticeable i.e with the decreased in sample thickness content of oleoresin decreases.

Table 4.18 Mean of oleoresin content of vacuum treated dried samples

S. No.	Treatment	Oleoresin content		
		Temperature (°C)		
		50	60	70
1	1cm cut	2.098	2.085	2.075
2	2cm cut	2.397	2.355	2.283

C. Curcumin content

The values of curcumin content as present in Table 4.19 reveled that the there was not much effect of temperature rather than the size of sample. As the thickness of sample is reduced the curcumin content goes on decreasing for all the drying temperature.

Table 4.19 Mean of curcumin content of vacuum treadet dried (powder) samples

S. No.	Treatment	curcumin content %		
		Temperature (°C)		
		50	60	70
1.	1cm cut	2.732	2.725	2.715
2.	2cm cut	2.875	2.865	2.842

 **Curring time: 15 min** **Sodium bicarbonate: 0.05%**	 **Curring time: 30 min** **Sodium bicarbonate: 0.05%**
 **Curring time: 15 min** **Sodium bicarbonate: 0.1%**	 **Curring time: 30 min** **Sodium bicarbonate: 0.1%**
 **Curring time: 15 min** **Sodium bicarbonate: 0.2%**	 **Curring time: 30 min** **Sodium bicarbonate: 0.2%**

 **Curring time: 45 min** **Sodium bicarbonate: 0.05%**	 **Curring time: 45 min** **Sodium bicarbonate: 0.1%**
 **Curring time: 45 min** **Sodium bicarbonate: 0.2%**	 **1cm cut** **Non- treated**
 **2cm cut** **Non –tearted**	 **3cm cut** **Non –tearted**

	
1cm cut **Vacuum treaded powder**	**2cm cut** **Vacuum treated powder**

Fig. 4.27 Turmeric powder obtained by different curing and non-curing treated

CHAPTER-V

SUMMARY AND CONCLUSION

Turmeric (*Curcuma Longa* L.), plant of the Zingiberaceae family, is commonly know as *haldi* in India. The rhizomes of this plant, when dried and ground, provide a yellow and flavourful powder, used for centuries as a natural coloring agent in food, cosmetics and textiles, as flavouring compound and also as insect repellent and as an Indian medicine (Govindarajan, 1980). Recently, it has been valued worldwide as functional food, due to its health promoting properties. Turmeric has been used as antioxidant, digestive, anti-microbial, anti-inflammatory and anti-carcinogenic agent. It lowers total cholesterol level. It is also efficient in the treatment of circulatory problems, liver diseases, dermatological disorders and a blood purification (Guimaraes, 1987; Srinivas et al., 1992; Hallagan et al., 1995; Oswa et al., 1995; Semwal et al., 1997).

Turmeric has the advantage of not requiring special cultural practices and it present good productivity. India has favourable conditions for turmeric cultivation, where it produced about 400,000 tone of turmeric in fresh weight per year which was about 80% of the world's supply of commercial turmeric. This tonnage was produced in an area of approximately 50,000 acres. The rhizomes are harvested and dried before shipment around the world.

In the processing of turmeric different unit operations are performed i.e. washing, cleaning, curing/boiling, drying, size reduction etc. But the most important unit operation is the curing/boiling. Also the unit operation was varied with the variation in the region. But, the curing/boiling is the main unit operation in the processing of turmeric. Generally in India turmeric rhizomes were boiled in alkaline media prior to dehydration. However, there are controversies with respect to the importance of cooking the rhizomes in water or alkaline solution prior to drying and its influence of the levels of curcuminoid pigments and on the colour of ground turmeric. Thus, the study is attempted to investigate the role/importance of curing/boiling process and to develop processing technology in order to obtain products of added value and good quality. Therefore, a study was proposed with the following specific objectives:

1. To study and document the different traditional practices used for turmeric processing in the state of Chhattisgarh.
2. Comparative evaluation of different pretreatments (adopted in common practices) used in turmeric processing and standardization of the suitable method.
3. To work on economic and time reduction technology for conversion of farm fresh turmeric rhizomes directly into dry concentrate.
4. To study the different quality parameters (physical & biochemical) of turmeric powder.

As per the first objective survey was conducted in the turmeric growing area of Chhattisgarh and documents the different traditional and commercial method used for processing. There was two traditional methods generally used, first is the curing/boiling of turmeric by addition small amount of cow dung and further open sun drying, second is curing/boiling of turmeric in normal water and the boiled sample were cut into pieces and further open sun drying. In case of commercial method turmeric rhizomes were washed thoroughly under high pressure water and boiled in a tar drum and further drying in open sun. In all this methods boiling/curing time is 45-60 min with their past experience. Also they are not going to follow any standard/scientific method i.e sample:water ratio, sample size, acidity/alkalinity of water, time of boiling, method of drying, initial moisture content and final moisture content of the produce.

For the standardization of processing method, fresh turmeric (var. *Shillong*) sample was procured in bulk from the Raipur market and was used for all experimental trials. Curing/boiling was done at three levels i.e. for 15, 30 and 45 min at different concentration of sodium bicarbonate i.e. 0.05, 0.1 and 0.2% and was further dried in convective tray dryer at 50, 60 and 70°C at constant air velocity of 1m/s. Under non-boiling treatment, first the turmeric rhizomes directly cut into pieces of thickness 1, 2 and 3 cm and further dried at three different drying air temperature (50, 60 and 70°C). In the second non-boiled treatments samples cut into pieces of thickness 1, 2 and 3 cm and treated into vacuum oven for 1h at a temperature of 60°C and at a pressure of 65 psi. and then again dried in a tray dryer at 50, 60 and 70°C at constant air velocity of 1m/s. The dried turmeric rhizomes received after different treatments were grind in a hammer mill and the quality of powder analysis on the basis of water activity, curcumin content and oleoresin content. alkaline solution. The quality of cured turmeric was evaluated. The boiling time of turmeric was optimized on the basis of overall acceptability and maximum curcumin content.

Based on the results of the investigation, the following conclusions were drawn:

1. There was two traditional methods generally used, first is the curing/boiling of turmeric by addition small amount of cow dung in an aluminium pot and the second is the boiling in normal water but the boiled sample were cut into pieces before further drying in sun.
2. The initial moisture content of fresh turmeric was found in the range of 79.25 - 82.49 percent (wb) and the final moisture content of dried turmeric rhizomes was found in the range of 3-7 percent (wb).
3. In case of boiling/curing process, a boiling time of 30 and 45 min is enough to attained uniform yellow colour and to reduce drying time.
4. In all the pre-treated samples with different boiling time and sodium bicarbonate percent drying time was reduced from 99-32 h with the increase in drying air temperature from 50 to 70°C.
5. Constant rate drying period was absent throughout the drying process of turmeric rhizomes under all drying air temperature.
6. Drying curves were affected by the drying air temperature and boiling/curing time.
7. The moisture diffusivity value increased with the increase in drying air temperature. The value of moisture diffusivity ranges from 2.22×10^{-10} to 4.12×10^{-10} m^2/s for all the convective dried sample.

8. All the process parameters i.e. boiling time (min), sodium bicarbonate (percent) and drying air temperature (°C) significantly affect the quality of final turmeric powder. The value of curcumin content varied from 3.280 to 2.983 percent and the value of oleoresin content varied from 2.398 to 2.983 percent.
9. The water activity of the entire dried sample was found in the range of 0.54-0.64 i.e. safe for storage.
10. In case of non-boiled turmeric sample with direct cut (1, 2 & 3 cm), drying time was reduced with the increased in the drying air temperature and at the same time with the decreased in the sample thickness. The required drying time observed in the range of 43 to 107 h for 70 to 50 °C.

SUGGESTION FOR FUTURE WORK

1. The work should be continued to improve the curing process of turmeric rhizome.
2. The work should be continued to finalize the vacuum treatment i.e temperature, vacuum pressure and time of treatment.
3. The work should be required to evaluate the shelf life of turmeric powder obtain from non-boiled process.

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APPENDIX- A

Initial moisture content by hot air oven method

S. No.	Treatment	Curing time	Temperature (°C)		
			50	60	70
1.	0.05%	15	78.22	78.22	78.22
2.	0.1%	15	78.36	78.36	78.36
3.	0.2%	15	78.43	78.43	78.43
4.	0.05%	30	78.50	78.50	78.50
5.	0.1%	30	78.63	78.63	78.63
6.	0.2%	30	78.70	78.70	78.70
7.	0.05%	45	78.89	78.89	78.89
8.	0.1%	45	78.96	78.96	78.96
9.	0.1%	45	78.96	78.96	78.96
10.	1cm cut		75.84	75.84	75.84
11.	2cm cut		76.12	76.12	76.12
12.	3cm cut		76.98	76.98	76.98

Initial moisture content by hot air oven method of vacuum treated sample

S. No.	Treatment	Temperature (°C)		
		50	60	70
1.	1cm cut	74.84	74.84	74.84
2.	2cm cut	75.98	75.98	75.98

APPENDIX- B

Tray dryer specification

MODELS	**TD-12**
Loading capacity	12 Trays
External Dimension in mm	W D H 1370 X 530 X 940
Internal Dimension in mm	840 X 430 X 840
No of Doors	One
No of Blowers	One
No of motors/H.P.3 PHASE 415 TS.	1/0.5 H.P.3 phase 415 ts.
Electrical Heating Load for 100°C/200°C/300°C	3kw/6kw/9kw
Steam Heater No. of coils.	2
Steam Pressure	3.3 kg/cm2
Insulation in mm 100°C/200°C/300°C	50/75/75
No of Trolleys	Rack System
Tray Size	812X 406 X 31
Trolley Dimension	Fixed Racks

APPENDIX- C

Pawkit water activity meter specification

Water Activity Range	0.00 to1.00 aw
Water Activity Accuracy	±0.02aw
Water Activity Resolution	±0.01aw
Read time	5 min
Sample Temperature Range	Na
Sample Temperature Accuracy	Na
Sample Temperature Resolution	Na
Sample Dish Capacity	7ml recommended (15ml full)
Operation Environment	4 to50°C, 0 to 90% Relative Humidity (non-condensing)
Case Dimensions	6.6×10.2×2.0cm
Weight	115g(4 oz)
Case Material	Stainless Steel And Valox 325 Plastic
Display	6-digit custom LCD with symbols
Data Communication	Na
Power	2-3 t 16mm coin cell batteries

APPENDIX- D

(Data sheet 1)

15(0.05%)	IMC	78.22					
	DryMatter	21.78					
	Wt. of DM	Initial Mass of Sample (DM%/100)			0.690426		
	EMC	0.712					
	50tem						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.17	359.4203	78.23344	3.594203	1	0	
2	3.02	337.6812	77.15232	3.376812	0.939396	-0.06252	0.362319
3	2.96	328.9855	76.68919	3.289855	0.915155	-0.08866	0.144928
4	2.88	317.3913	76.04167	3.173913	0.882832	-0.12462	0.193237
5	2.8	305.7971	75.35714	3.057971	0.85051	-0.16192	0.193237
6	2.72	294.2029	74.63235	2.942029	0.818188	-0.20066	0.193237
7	2.66	285.5072	74.06015	2.855072	0.793947	-0.23074	0.144928
8	2.52	265.2174	72.61905	2.652174	0.737383	-0.30465	0.338164
9	2.477	258.9855	72.14372	2.589855	0.72001	-0.32849	0.103865
10	2.4	247.8261	71.25	2.478261	0.6889	-0.37266	0.18599
11	2.36	242.029	70.76271	2.42029	0.672739	-0.3964	0.096618
12	2.32	236.2319	70.25862	2.362319	0.656578	-0.42071	0.096618
13	2.28	230.4348	69.73684	2.304348	0.640417	-0.44564	0.096618
14	2.2	218.8406	68.63636	2.188406	0.608095	-0.49742	0.193237
15	2.12	207.2464	67.45283	2.072464	0.575773	-0.55204	0.193237
16	2.06	198.5507	66.50485	1.985507	0.551531	-0.59506	0.144928
17	2.02	192.7536	65.84158	1.927536	0.53537	-0.6248	0.096618
18	1.98	186.9565	65.15152	1.869565	0.519209	-0.65545	0.096618
19	1.94	181.1594	64.43299	1.811594	0.503048	-0.68707	0.096618
20	1.9	175.3623	63.68421	1.753623	0.486887	-0.71972	0.096618
21	1.86	169.5652	62.90323	1.695652	0.470726	-0.75348	0.096618
22	1.82	163.7681	62.08791	1.637681	0.454565	-0.78842	0.096618
23	1.74	152.1739	60.34483	1.521739	0.422243	-0.86218	0.193237
24	1.7	146.3768	59.41176	1.463768	0.406082	-0.9012	0.096618
25	1.66	140.5797	58.43373	1.405797	0.38992	-0.94181	0.096618
26	1.62	134.7826	57.40741	1.347826	0.373759	-0.98414	0.096618
27	1.58	128.9855	56.32911	1.289855	0.357598	-1.02834	0.096618
28	1.54	123.1884	55.19481	1.231884	0.341437	-1.07459	0.096618
29	1.52	120.2899	54.60526	1.202899	0.333357	-1.09854	0.048309
30	1.47	113.0435	53.06122	1.130435	0.313156	-1.16106	0.120773
31	1.42	105.7971	51.40845	1.057971	0.292954	-1.22774	0.120773
32	1.4	102.8986	50.71429	1.028986	0.284874	-1.25571	0.048309
33	1.38	100	50	1	0.276793	-1.28448	0.048309
34	1.36	97.10145	49.26471	0.971014	0.268713	-1.31411	0.048309
35	1.32	91.30435	47.72727	0.913043	0.252552	-1.37614	0.096618
36	1.28	85.50725	46.09375	0.855072	0.236391	-1.44227	0.096618
37	1.26	82.6087	45.2381	0.826087	0.22831	-1.47705	0.048309
38	1.24	79.71014	44.35484	0.797101	0.220229	-1.51309	0.048309
39	1.22	76.81159	43.44262	0.768116	0.212149	-1.55047	0.048309
40	1.2	73.91304	42.5	0.73913	0.204068	-1.5893	0.048309

41	1.16	68.11594	40.51724	0.681159	0.187907	-1.67181	0.096618
42	1.14	65.21739	39.47368	0.652174	0.179827	-1.71576	0.048309
43	1.12	62.31884	38.39286	0.623188	0.171746	-1.76174	0.048309
44	1.1	59.42029	37.27273	0.594203	0.163666	-1.80993	0.048309
45	1.08	56.52174	36.11111	0.565217	0.155585	-1.86056	0.048309
46	1.06	53.62319	34.90566	0.536232	0.147505	-1.91389	0.048309
47	1.04	50.72464	33.65385	0.507246	0.139424	-1.97023	0.048309
48	1.02	47.82609	32.35294	0.478261	0.131344	-2.02994	0.048309
49	1.01	46.37681	31.68317	0.463768	0.127303	-2.06118	0.024155
50	1	44.92754	31	0.449275	0.123263	-2.09343	0.024155
51	0.99	43.47826	30.30303	0.434783	0.119223	-2.12676	0.024155
52	0.98	42.02899	29.59184	0.42029	0.115183	-2.16124	0.024155
53	0.97	40.57971	28.86598	0.405797	0.111142	-2.19694	0.024155
54	0.96	39.13043	28.125	0.391304	0.107102	-2.23397	0.024155
55	0.95	37.68116	27.36842	0.376812	0.103062	-2.27243	0.024155
56	0.94	36.23188	26.59574	0.362319	0.099022	-2.31242	0.024155
57	0.93	34.78261	25.80645	0.347826	0.094981	-2.35407	0.024155
58	0.92	33.33333	25	0.333333	0.090941	-2.39754	0.024155
59	0.91	31.88406	24.17582	0.318841	0.086901	-2.44299	0.024155
60	0.9	30.43478	23.33333	0.304348	0.082861	-2.4906	0.024155
61	0.89	28.98551	22.47191	0.289855	0.07882	-2.54058	0.024155
62	0.88	27.53623	21.59091	0.275362	0.07478	-2.5932	0.024155
63	0.87	26.08696	20.68966	0.26087	0.07074	-2.64875	0.024155
64	0.86	24.63768	19.76744	0.246377	0.0667	-2.70756	0.024155
65	0.85	23.18841	18.82353	0.231884	0.062659	-2.77004	0.024155
66	0.84	21.73913	17.85714	0.217391	0.058619	-2.8367	0.024155
67	0.83	20.28986	16.86747	0.202899	0.054579	-2.90811	0.024155
68	0.82	18.84058	15.85366	0.188406	0.050539	-2.98502	0.024155
69	0.81	17.3913	14.81481	0.173913	0.046498	-3.06834	0.024155
70	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.024155
71	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
72	0.785	13.76812	12.10191	0.137681	0.036398	-3.31325	0.012077
73	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.012077
74	0.775	12.31884	10.96774	0.123188	0.032357	-3.43091	0.012077
75	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.012077
76	0.765	10.86957	9.803922	0.108696	0.028317	-3.56429	0.012077
77	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.012077
78	0.755	9.42029	8.609272	0.094203	0.024277	-3.71823	0.012077
79	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.012077
80	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
81	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
82	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
83	0.731	5.942029	5.608755	0.05942	0.01458	-4.22809	0.009662
84	0.729	5.652174	5.349794	0.056522	0.013772	-4.28511	0.004831
85	0.726	5.217391	4.958678	0.052174	0.01256	-4.37723	0.007246
86	0.724	4.927536	4.696133	0.049275	0.011752	-4.44373	0.004831
87	0.722	4.637681	4.432133	0.046377	0.010944	-4.51497	0.004831
88	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.002415
89	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.002415
90	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
91	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
92	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0

93	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
94	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0
95	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
96	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
97	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
98	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
99	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 2)

15(0.05%)	IMC	78.22					
	Dry Matter	21.78					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.690426		
	EMC	0.714					
	60tem						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.17	359.4203	78.23344	3.594203	1	0	
2	2.99	333.3333	76.92308	3.333333	0.927275	-0.0755	0.434783
3	2.88	317.3913	76.04167	3.173913	0.882832	-0.12462	0.2657
4	2.79	304.3478	75.26882	3.043478	0.84647	-0.16668	0.217391
5	2.66	285.5072	74.06015	2.855072	0.793947	-0.23074	0.31401
6	2.59	275.3623	73.35907	2.753623	0.765665	-0.26701	0.169082
7	2.5	262.3188	72.4	2.623188	0.729302	-0.31567	0.217391
8	2.43	252.1739	71.60494	2.521739	0.701021	-0.35522	0.169082
9	2.38	244.9275	71.0084	2.449275	0.680819	-0.38446	0.120773
10	2.24	224.6377	69.19643	2.246377	0.624256	-0.4712	0.338164
11	2.12	207.2464	67.45283	2.072464	0.575773	-0.55204	0.289855
12	2.01	191.3043	65.67164	1.913043	0.53133	-0.63237	0.2657
13	1.96	184.058	64.79592	1.84058	0.511128	-0.67113	0.120773
14	1.88	172.4638	63.29787	1.724638	0.478806	-0.73646	0.193237
15	1.8	160.8696	61.66667	1.608696	0.446484	-0.80635	0.193237
16	1.74	152.1739	60.34483	1.521739	0.422243	-0.86218	0.144928
17	1.68	143.4783	58.92857	1.434783	0.398001	-0.9213	0.144928
18	1.63	136.2319	57.66871	1.362319	0.3778	-0.97339	0.120773
19	1.52	120.2899	54.60526	1.202899	0.333357	-1.09854	0.2657
20	1.46	111.5942	52.73973	1.115942	0.309115	-1.17404	0.144928
21	1.41	104.3478	51.06383	1.043478	0.288914	-1.24163	0.120773
22	1.37	98.55072	49.63504	0.985507	0.272753	-1.29919	0.096618
23	1.33	92.75362	48.1203	0.927536	0.256592	-1.36027	0.096618
24	1.29	86.95652	46.51163	0.869565	0.240431	-1.42532	0.096618
25	1.25	81.15942	44.8	0.811594	0.22427	-1.49491	0.096618
26	1.21	75.36232	42.97521	0.753623	0.208109	-1.56969	0.096618
27	1.17	69.56522	41.02564	0.695652	0.191948	-1.65053	0.096618
28	1.13	63.76812	38.93805	0.637681	0.175787	-1.73848	0.096618
29	1.09	57.97101	36.69725	0.57971	0.159626	-1.83492	0.096618
30	1.07	55.07246	35.51402	0.550725	0.151545	-1.88687	0.048309
31	1.05	52.17391	34.28571	0.521739	0.143465	-1.94167	0.048309
32	1.03	49.27536	33.00971	0.492754	0.135384	-1.99964	0.048309

33	1.01	46.37681	31.68317	0.463768	0.127303	-2.06118	0.048309
34	0.99	43.47826	30.30303	0.434783	0.119223	-2.12676	0.048309
35	0.97	40.57971	28.86598	0.405797	0.111142	-2.19694	0.048309
36	0.94	36.23188	26.59574	0.362319	0.099022	-2.31242	0.072464
37	0.92	33.33333	25	0.333333	0.090941	-2.39754	0.048309
38	0.9	30.43478	23.33333	0.304348	0.082861	-2.4906	0.048309
39	0.88	27.53623	21.59091	0.275362	0.07478	-2.5932	0.048309
40	0.86	24.63768	19.76744	0.246377	0.0667	-2.70756	0.048309
41	0.85	23.18841	18.82353	0.231884	0.062659	-2.77004	0.024155
42	0.83	20.28986	16.86747	0.202899	0.054579	-2.90811	0.048309
43	0.81	17.3913	14.81481	0.173913	0.046498	-3.06834	0.048309
44	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.024155
45	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
46	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
47	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
48	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
49	0.755	9.42029	8.609272	0.094203	0.024277	-3.71823	0.012077
50	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.012077
51	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
52	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.024155
53	0.731	5.942029	5.608755	0.05942	0.01458	-4.22809	0.009662
54	0.728	5.507246	5.21978	0.055072	0.013368	-4.31488	0.007246
55	0.725	5.072464	4.827586	0.050725	0.012156	-4.40993	0.007246
56	0.723	4.782609	4.564315	0.047826	0.011348	-4.47872	0.004831
57	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.004831
58	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.002415
59	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
60	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
61	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
62	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
63	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
64	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
65	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
66	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet -3)

15(0.05%)	IMC	78.22					
	Dry Matter	21.78					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.690426		
	EMC	0.714					
	70 tem						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.17	359.4203	78.23344	3.594203	1	0	
2	2.93	324.6377	76.45051	3.246377	0.903034	-0.102	0.57971
3	2.83	310.1449	75.61837	3.101449	0.862631	-0.14777	0.241546
4	2.63	281.1594	73.76426	2.811594	0.781826	-0.24612	0.483092

5	2.56	271.0145	73.04688	2.710145	0.753544	-0.28297	0.169082
6	2.46	256.5217	71.95122	2.565217	0.713141	-0.33808	0.241546
7	2.35	240.5797	70.6383	2.405797	0.668699	-0.40242	0.2657
8	2.25	226.087	69.33333	2.26087	0.628296	-0.46474	0.241546
9	2.16	213.0435	68.05556	2.130435	0.591934	-0.52436	0.217391
10	2.06	198.5507	66.50485	1.985507	0.551531	-0.59506	0.241546
11	1.96	184.058	64.79592	1.84058	0.511128	-0.67113	0.241546
12	1.88	172.4638	63.29787	1.724638	0.478806	-0.73646	0.193237
13	1.8	160.8696	61.66667	1.608696	0.446484	-0.80635	0.193237
14	1.72	149.2754	59.88372	1.492754	0.414162	-0.8815	0.193237
15	1.66	140.5797	58.43373	1.405797	0.38992	-0.94181	0.144928
16	1.58	128.9855	56.32911	1.289855	0.357598	-1.02834	0.193237
17	1.5	117.3913	54	1.173913	0.325276	-1.12308	0.193237
18	1.42	105.7971	51.40845	1.057971	0.292954	-1.22774	0.193237
19	1.36	97.10145	49.26471	0.971014	0.268713	-1.31411	0.144928
20	1.3	88.4058	46.92308	0.884058	0.244471	-1.40866	0.144928
21	1.24	79.71014	44.35484	0.797101	0.220229	-1.51309	0.144928
22	1.18	71.01449	41.52542	0.710145	0.195988	-1.6297	0.144928
23	1.12	62.31884	38.39286	0.623188	0.171746	-1.76174	0.144928
24	1.06	53.62319	34.90566	0.536232	0.147505	-1.91389	0.144928
25	1	44.92754	31	0.449275	0.123263	-2.09343	0.144928
26	0.96	39.13043	28.125	0.391304	0.107102	-2.23397	0.096618
27	0.92	33.33333	25	0.333333	0.090941	-2.39754	0.096618
28	0.88	27.53623	21.59091	0.275362	0.07478	-2.5932	0.096618
29	0.84	21.73913	17.85714	0.217391	0.058619	-2.8367	0.096618
30	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.096618
31	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
32	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
33	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
34	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
35	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.024155
36	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
37	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
38	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
39	0.73	5.797101	5.479452	0.057971	0.014176	-4.25619	0.012077
40	0.726	5.217391	4.958678	0.052174	0.01256	-4.37723	0.009662
41	0.723	4.782609	4.564315	0.047826	0.011348	-4.47872	0.007246
42	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.007246
43	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.007246
44	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.004831
45	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 1)

15(0.1%)	IMC	78.36					
	Dry Matter	21.64					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.690316		
	EMC	0.714					
	50						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.19	362.3188	78.36991	3.623188	1.008081	0	
2	3.06	343.4783	77.45098	3.434783	0.955557	-0.04546	0.31401
3	2.96	328.9855	76.68919	3.289855	0.915155	-0.08866	0.241546
4	2.87	315.942	75.95819	3.15942	0.878792	-0.12921	0.217391
5	2.79	304.3478	75.26882	3.043478	0.84647	-0.16668	0.193237
6	2.71	292.7536	74.53875	2.927536	0.814148	-0.20561	0.193237
7	2.65	284.058	73.96226	2.84058	0.789906	-0.23584	0.144928
8	2.51	263.7681	72.50996	2.637681	0.733343	-0.31014	0.338164
9	2.46	256.5217	71.95122	2.565217	0.713141	-0.33808	0.120773
10	2.423	251.1594	71.52291	2.511594	0.698192	-0.35926	0.089372
11	2.35	240.5797	70.6383	2.405797	0.668699	-0.40242	0.176329
12	2.31	234.7826	70.12987	2.347826	0.652537	-0.42689	0.096618
13	2.214	220.8696	68.83469	2.208696	0.613751	-0.48817	0.231884
14	2.178	215.6522	68.31956	2.156522	0.599206	-0.51215	0.086957
15	2.11	205.7971	67.29858	2.057971	0.571732	-0.55908	0.164251
16	2.05	197.1014	66.34146	1.971014	0.547491	-0.60241	0.144928
17	2.01	191.3043	65.67164	1.913043	0.53133	-0.63237	0.096618
18	1.97	185.5072	64.97462	1.855072	0.515169	-0.66326	0.096618
19	1.93	179.7101	64.2487	1.797101	0.499008	-0.69513	0.096618
20	1.89	173.913	63.49206	1.73913	0.482847	-0.72806	0.096618
21	1.85	168.1159	62.7027	1.681159	0.466685	-0.7621	0.096618
22	1.81	162.3188	61.87845	1.623188	0.450524	-0.79734	0.096618
23	1.73	150.7246	60.11561	1.507246	0.418202	-0.87179	0.193237
24	1.68	143.4783	58.92857	1.434783	0.398001	-0.9213	0.120773
25	1.64	137.6812	57.92683	1.376812	0.38184	-0.96275	0.096618
26	1.6	131.8841	56.875	1.318841	0.365679	-1.006	0.096618
27	1.56	126.087	55.76923	1.26087	0.349518	-1.0512	0.096618
28	1.52	120.2899	54.60526	1.202899	0.333357	-1.09854	0.096618
29	1.5	117.3913	54	1.173913	0.325276	-1.12308	0.048309
30	1.45	110.1449	52.41379	1.101449	0.305075	-1.1872	0.120773
31	1.41	104.3478	51.06383	1.043478	0.288914	-1.24163	0.096618
32	1.39	101.4493	50.35971	1.014493	0.280833	-1.26999	0.048309
33	1.37	98.55072	49.63504	0.985507	0.272753	-1.29919	0.048309
34	1.35	95.65217	48.88889	0.956522	0.264672	-1.32926	0.048309
35	1.31	89.85507	47.32824	0.898551	0.248511	-1.39227	0.096618
36	1.27	84.05797	45.66929	0.84058	0.23235	-1.45951	0.096618
37	1.25	81.15942	44.8	0.811594	0.22427	-1.49491	0.048309
38	1.23	78.26087	43.90244	0.782609	0.216189	-1.5316	0.048309
39	1.21	75.36232	42.97521	0.753623	0.208109	-1.56969	0.048309
40	1.19	72.46377	42.01681	0.724638	0.200028	-1.6093	0.048309
41	1.15	66.66667	40	0.666667	0.183867	-1.69354	0.096618

42	1.13	63.76812	38.93805	0.637681	0.175787	-1.73848	0.048309
43	1.11	60.86957	37.83784	0.608696	0.167706	-1.78554	0.048309
44	1.09	57.97101	36.69725	0.57971	0.159626	-1.83492	0.048309
45	1.07	55.07246	35.51402	0.550725	0.151545	-1.88687	0.048309
46	1.05	52.17391	34.28571	0.521739	0.143465	-1.94167	0.048309
47	1.03	49.27536	33.00971	0.492754	0.135384	-1.99964	0.048309
48	1.01	46.37681	31.68317	0.463768	0.127303	-2.06118	0.048309
49	1	44.92754	31	0.449275	0.123263	-2.09343	0.024155
50	0.99	43.47826	30.30303	0.434783	0.119223	-2.12676	0.024155
51	0.98	42.02899	29.59184	0.42029	0.115183	-2.16124	0.024155
52	0.97	40.57971	28.86598	0.405797	0.111142	-2.19694	0.024155
53	0.96	39.13043	28.125	0.391304	0.107102	-2.23397	0.024155
54	0.95	37.68116	27.36842	0.376812	0.103062	-2.27243	0.024155
55	0.94	36.23188	26.59574	0.362319	0.099022	-2.31242	0.024155
56	0.93	34.78261	25.80645	0.347826	0.094981	-2.35407	0.024155
57	0.92	33.33333	25	0.333333	0.090941	-2.39754	0.024155
58	0.91	31.88406	24.17582	0.318841	0.086901	-2.44299	0.024155
59	0.9	30.43478	23.33333	0.304348	0.082861	-2.4906	0.024155
60	0.89	28.98551	22.47191	0.289855	0.07882	-2.54058	0.024155
61	0.88	27.53623	21.59091	0.275362	0.07478	-2.5932	0.024155
62	0.87	26.08696	20.68966	0.26087	0.07074	-2.64875	0.024155
63	0.86	24.63768	19.76744	0.246377	0.0667	-2.70756	0.024155
64	0.85	23.18841	18.82353	0.231884	0.062659	-2.77004	0.024155
65	0.84	21.73913	17.85714	0.217391	0.058619	-2.8367	0.024155
66	0.83	20.28986	16.86747	0.202899	0.054579	-2.90811	0.024155
67	0.82	18.84058	15.85366	0.188406	0.050539	-2.98502	0.024155
68	0.81	17.3913	14.81481	0.173913	0.046498	-3.06834	0.024155
69	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.024155
70	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
71	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
72	0.775	12.31884	10.96774	0.123188	0.032357	-3.43091	0.012077
73	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.012077
74	0.765	10.86957	9.803922	0.108696	0.028317	-3.56429	0.012077
75	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.012077
76	0.755	9.42029	8.609272	0.094203	0.024277	-3.71823	0.012077
77	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.012077
78	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
79	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
80	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
81	0.731	5.942029	5.608755	0.05942	0.01458	-4.22809	0.009662
82	0.729	5.652174	5.349794	0.056522	0.013772	-4.28511	0.004831
83	0.726	5.217391	4.958678	0.052174	0.01256	-4.37723	0.007246
84	0.724	4.927536	4.696133	0.049275	0.011752	-4.44373	0.004831
85	0.722	4.637681	4.432133	0.046377	0.010944	-4.51497	0.004831
86	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.002415
87	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.002415
88	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
89	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
90	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0
91	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
92	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0
93	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415

94	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
95	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
96	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
97	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 2)

15(0.1%)	IMC	78.36					
	Dry Matter	21.64					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.690316		
	EMC	0.714					
	60						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.19	362.3188	78.36991	3.623188	1.008081	0	
2	2.99	333.3333	76.92308	3.333333	0.927275	-0.0755	0.483092
3	2.89	318.8406	76.12457	3.188406	0.886873	-0.12005	0.241546
4	2.74	297.1014	74.81752	2.971014	0.826269	-0.19084	0.362319
5	2.668	286.6667	74.13793	2.866667	0.797179	-0.22668	0.173913
6	2.531	266.8116	72.73805	2.668116	0.741827	-0.29864	0.330918
7	2.423	251.1594	71.52291	2.511594	0.698192	-0.35926	0.26087
8	2.321	236.3768	70.27143	2.363768	0.656982	-0.4201	0.246377
9	2.238	224.3478	69.1689	2.243478	0.623448	-0.47249	0.200483
10	2.16	213.0435	68.05556	2.130435	0.591934	-0.52436	0.188406
11	2.08	201.4493	66.82692	2.014493	0.559611	-0.58051	0.193237
12	2	189.8551	65.5	1.898551	0.527289	-0.64001	0.193237
13	1.95	182.6087	64.61538	1.826087	0.507088	-0.67907	0.120773
14	1.87	171.0145	63.1016	1.710145	0.474766	-0.74493	0.193237
15	1.79	159.4203	61.45251	1.594203	0.442444	-0.81544	0.193237
16	1.73	150.7246	60.11561	1.507246	0.418202	-0.87179	0.144928
17	1.67	142.029	58.68263	1.42029	0.393961	-0.9315	0.144928
18	1.562	126.3768	55.82586	1.263768	0.350326	-1.04889	0.26087
19	1.51	118.8406	54.30464	1.188406	0.329317	-1.11074	0.125604
20	1.45	110.1449	52.41379	1.101449	0.305075	-1.1872	0.144928
21	1.4	102.8986	50.71429	1.028986	0.284874	-1.25571	0.120773
22	1.36	97.10145	49.26471	0.971014	0.268713	-1.31411	0.096618
23	1.32	91.30435	47.72727	0.913043	0.252552	-1.37614	0.096618
24	1.28	85.50725	46.09375	0.855072	0.236391	-1.44227	0.096618
25	1.24	79.71014	44.35484	0.797101	0.220229	-1.51309	0.096618
26	1.2	73.91304	42.5	0.73913	0.204068	-1.5893	0.096618
27	1.16	68.11594	40.51724	0.681159	0.187907	-1.67181	0.096618
28	1.12	62.31884	38.39286	0.623188	0.171746	-1.76174	0.096618
29	1.08	56.52174	36.11111	0.565217	0.155585	-1.86056	0.096618
30	1.06	53.62319	34.90566	0.536232	0.147505	-1.91389	0.048309
31	1.04	50.72464	33.65385	0.507246	0.139424	-1.97023	0.048309
32	1.02	47.82609	32.35294	0.478261	0.131344	-2.02994	0.048309
33	1	44.92754	31	0.449275	0.123263	-2.09343	0.048309
34	0.98	42.02899	29.59184	0.42029	0.115183	-2.16124	0.048309
35	0.96	39.13043	28.125	0.391304	0.107102	-2.23397	0.048309

36	0.93	34.78261	25.80645	0.347826	0.094981	-2.35407	0.072464
37	0.91	31.88406	24.17582	0.318841	0.086901	-2.44299	0.048309
38	0.89	28.98551	22.47191	0.289855	0.07882	-2.54058	0.048309
39	0.87	26.08696	20.68966	0.26087	0.07074	-2.64875	0.048309
40	0.85	23.18841	18.82353	0.231884	0.062659	-2.77004	0.048309
41	0.84	21.73913	17.85714	0.217391	0.058619	-2.8367	0.024155
42	0.82	18.84058	15.85366	0.188406	0.050539	-2.98502	0.048309
43	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.048309
44	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
45	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
46	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
47	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
48	0.755	9.42029	8.609272	0.094203	0.024277	-3.71823	0.012077
49	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.012077
50	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
51	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.024155
52	0.731	5.942029	5.608755	0.05942	0.01458	-4.22809	0.009662
53	0.728	5.507246	5.21978	0.055072	0.013368	-4.31488	0.007246
54	0.725	5.072464	4.827586	0.050725	0.012156	-4.40993	0.007246
55	0.723	4.782609	4.564315	0.047826	0.011348	-4.47872	0.004831
56	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.007246
57	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
58	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
59	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
60	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
61	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
62	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
63	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
64	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 3)

15(0.1%)	IMC	78.36					
	Dry						
	Matter	21.64					
	Wt. of	Initial Mass of Sample ×					
	DM	(DM%/100)			0.690316		
	EMC	0.714					
	70						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.19	362.3188	78.36991	3.623188	1.008081	0	
2	2.92	323.1884	76.36986	3.231884	0.898993	-0.10648	0.652174
3	2.81	307.2464	75.44484	3.072464	0.854551	-0.15718	0.2657
4	2.6	276.8116	73.46154	2.768116	0.769705	-0.26175	0.507246
5	2.441	253.7681	71.7329	2.537681	0.705465	-0.3489	0.384058
6	2.345	239.8551	70.57569	2.398551	0.666678	-0.40545	0.231884
7	2.238	224.3478	69.1689	2.243478	0.623448	-0.47249	0.258454
8	2.142	210.4348	67.78711	2.104348	0.584661	-0.53672	0.231884
9	2.088	202.6087	66.95402	2.026087	0.562844	-0.57475	0.130435
10	2.004	190.4348	65.56886	1.904348	0.528905	-0.63695	0.202899

11	1.95	182.6087	64.61538	1.826087	0.507088	-0.67907	0.130435
12	1.87	171.0145	63.1016	1.710145	0.474766	-0.74493	0.193237
13	1.79	159.4203	61.45251	1.594203	0.442444	-0.81544	0.193237
14	1.71	147.8261	59.64912	1.478261	0.410122	-0.8913	0.193237
15	1.65	139.1304	58.18182	1.391304	0.38588	-0.95223	0.144928
16	1.57	127.5362	56.05096	1.275362	0.353558	-1.03971	0.193237
17	1.49	115.942	53.69128	1.15942	0.321236	-1.13558	0.193237
18	1.41	104.3478	51.06383	1.043478	0.288914	-1.24163	0.193237
19	1.35	95.65217	48.88889	0.956522	0.264672	-1.32926	0.144928
20	1.29	86.95652	46.51163	0.869565	0.240431	-1.42532	0.144928
21	1.23	78.26087	43.90244	0.782609	0.216189	-1.5316	0.144928
22	1.17	69.56522	41.02564	0.695652	0.191948	-1.65053	0.144928
23	1.11	60.86957	37.83784	0.608696	0.167706	-1.78554	0.144928
24	1.05	52.17391	34.28571	0.521739	0.143465	-1.94167	0.144928
25	0.99	43.47826	30.30303	0.434783	0.119223	-2.12676	0.144928
26	0.95	37.68116	27.36842	0.376812	0.103062	-2.27243	0.096618
27	0.91	31.88406	24.17582	0.318841	0.086901	-2.44299	0.096618
28	0.87	26.08696	20.68966	0.26087	0.07074	-2.64875	0.096618
29	0.83	20.28986	16.86747	0.202899	0.054579	-2.90811	0.096618
30	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.096618
31	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
32	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
33	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
34	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.024155
35	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
36	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
37	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
38	0.73	5.797101	5.479452	0.057971	0.014176	-4.25619	0.012077
39	0.725	5.072464	4.827586	0.050725	0.012156	-4.40993	0.012077
40	0.723	4.782609	4.564315	0.047826	0.011348	-4.47872	0.004831
41	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.009662
42	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.004831
43	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.004831
44	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 1)

15(0.2%)	IMC	78.43					
	Dry Matter	21.57					
	Wt. of DM	Initial Mass of Sample × (DM%/100)		0.69024			
	EMC	0.714					
	50						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.2	363.7681	78.4375	3.637681	1.012121	0	
2	3.05	342.029	77.37705	3.42029	0.951517	-0.0497	0.362319
3	2.95	327.5362	76.61017	3.275362	0.911114	-0.09309	0.241546
4	2.86	314.4928	75.87413	3.144928	0.874752	-0.13381	0.217391
5	2.78	302.8986	75.17986	3.028986	0.84243	-0.17146	0.193237

6	2.7	291.3043	74.44444	2.913043	0.810108	-0.21059	0.193237
7	2.63	281.1594	73.76426	2.811594	0.781826	-0.24612	0.169082
8	2.5	262.3188	72.4	2.623188	0.729302	-0.31567	0.31401
9	2.44	253.6232	71.72131	2.536232	0.705061	-0.34947	0.144928
10	2.38	244.9275	71.0084	2.449275	0.680819	-0.38446	0.144928
11	2.34	239.1304	70.51282	2.391304	0.664658	-0.40848	0.096618
12	2.3	233.3333	70	2.333333	0.648497	-0.4331	0.096618
13	2.26	227.5362	69.46903	2.275362	0.632336	-0.45833	0.096618
14	2.22	221.7391	68.91892	2.217391	0.616175	-0.48422	0.096618
15	2.1	204.3478	67.14286	2.043478	0.567692	-0.56618	0.289855
16	2.04	195.6522	66.17647	1.956522	0.54345	-0.60982	0.144928
17	2	189.8551	65.5	1.898551	0.527289	-0.64001	0.096618
18	1.96	184.058	64.79592	1.84058	0.511128	-0.67113	0.096618
19	1.92	178.2609	64.0625	1.782609	0.494967	-0.70326	0.096618
20	1.88	172.4638	63.29787	1.724638	0.478806	-0.73646	0.096618
21	1.84	166.6667	62.5	1.666667	0.462645	-0.77079	0.096618
22	1.8	160.8696	61.66667	1.608696	0.446484	-0.80635	0.096618
23	1.72	149.2754	59.88372	1.492754	0.414162	-0.8815	0.193237
24	1.67	142.029	58.68263	1.42029	0.393961	-0.9315	0.120773
25	1.63	136.2319	57.66871	1.362319	0.3778	-0.97339	0.096618
26	1.59	130.4348	56.60377	1.304348	0.361639	-1.01711	0.096618
27	1.54	123.1884	55.19481	1.231884	0.341437	-1.07459	0.120773
28	1.5	117.3913	54	1.173913	0.325276	-1.12308	0.096618
29	1.48	114.4928	53.37838	1.144928	0.317196	-1.14824	0.048309
30	1.43	107.2464	51.74825	1.072464	0.296994	-1.21404	0.120773
31	1.39	101.4493	50.35971	1.014493	0.280833	-1.26999	0.096618
32	1.37	98.55072	49.63504	0.985507	0.272753	-1.29919	0.048309
33	1.35	95.65217	48.88889	0.956522	0.264672	-1.32926	0.048309
34	1.34	94.2029	48.50746	0.942029	0.260632	-1.34465	0.024155
35	1.29	86.95652	46.51163	0.869565	0.240431	-1.42532	0.120773
36	1.25	81.15942	44.8	0.811594	0.22427	-1.49491	0.096618
37	1.23	78.26087	43.90244	0.782609	0.216189	-1.5316	0.048309
38	1.21	75.36232	42.97521	0.753623	0.208109	-1.56969	0.048309
39	1.19	72.46377	42.01681	0.724638	0.200028	-1.6093	0.048309
40	1.17	69.56522	41.02564	0.695652	0.191948	-1.65053	0.048309
41	1.13	63.76812	38.93805	0.637681	0.175787	-1.73848	0.096618
42	1.11	60.86957	37.83784	0.608696	0.167706	-1.78554	0.048309
43	1.09	57.97101	36.69725	0.57971	0.159626	-1.83492	0.048309
44	1.07	55.07246	35.51402	0.550725	0.151545	-1.88687	0.048309
45	1.05	52.17391	34.28571	0.521739	0.143465	-1.94167	0.048309
46	1.03	49.27536	33.00971	0.492754	0.135384	-1.99964	0.048309
47	1.01	46.37681	31.68317	0.463768	0.127303	-2.06118	0.048309
48	0.99	43.47826	30.30303	0.434783	0.119223	-2.12676	0.048309
49	0.98	42.02899	29.59184	0.42029	0.115183	-2.16124	0.024155
50	0.97	40.57971	28.86598	0.405797	0.111142	-2.19694	0.024155
51	0.96	39.13043	28.125	0.391304	0.107102	-2.23397	0.024155
52	0.95	37.68116	27.36842	0.376812	0.103062	-2.27243	0.024155
53	0.94	36.23188	26.59574	0.362319	0.099022	-2.31242	0.024155
54	0.93	34.78261	25.80645	0.347826	0.094981	-2.35407	0.024155
55	0.91	31.88406	24.17582	0.318841	0.086901	-2.44299	0.048309
56	0.9	30.43478	23.33333	0.304348	0.082861	-2.4906	0.024155
57	0.89	28.98551	22.47191	0.289855	0.07882	-2.54058	0.024155

58	0.88	27.53623	21.59091	0.275362	0.07478	-2.5932	0.024155
59	0.87	26.08696	20.68966	0.26087	0.07074	-2.64875	0.024155
60	0.86	24.63768	19.76744	0.246377	0.0667	-2.70756	0.024155
61	0.85	23.18841	18.82353	0.231884	0.062659	-2.77004	0.024155
62	0.84	21.73913	17.85714	0.217391	0.058619	-2.8367	0.024155
63	0.83	20.28986	16.86747	0.202899	0.054579	-2.90811	0.024155
64	0.82	18.84058	15.85366	0.188406	0.050539	-2.98502	0.024155
65	0.81	17.3913	14.81481	0.173913	0.046498	-3.06834	0.024155
66	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.024155
68	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
69	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
70	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
71	0.755	9.42029	8.609272	0.094203	0.024277	-3.71823	0.012077
72	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.012077
73	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
74	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
75	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
76	0.731	5.942029	5.608755	0.05942	0.01458	-4.22809	0.009662
77	0.729	5.652174	5.349794	0.056522	0.013772	-4.28511	0.004831
78	0.726	5.217391	4.958678	0.052174	0.01256	-4.37723	0.007246
79	0.724	4.927536	4.696133	0.049275	0.011752	-4.44373	0.004831
80	0.722	4.637681	4.432133	0.046377	0.010944	-4.51497	0.004831
81	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.002415
82	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.002415
83	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
84	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
85	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0
86	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
87	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0
88	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
89	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
90	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
91	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
92	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

15(0.2%)	IMC	78.43	
	Dry Matter	21.57	
	Initial Mass of Sample × (DM%/100)		0.69024
	0.714		

Time(h)	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	363.7681	78.4375	3.637681	1.012121	0	
2	330.4348	76.76768	3.304348	0.919195	-0.08426	0.555556
3	320.2899	76.2069	3.202899	0.890913	-0.11551	0.169082
4	295.6522	74.72527	2.956522	0.822228	-0.19574	0.410628
5	278.2609	73.56322	2.782609	0.773745	-0.25651	0.289855
6	263.7681	72.50996	2.637681	0.733343	-0.31014	0.241546

7	253.6232	71.72131	2.536232	0.705061	-0.34947	0.169082
8	233.3333	70	2.333333	0.648497	-0.4331	0.338164
9	217.3913	68.49315	2.173913	0.604054	-0.50409	0.2657
10	195.6522	66.17647	1.956522	0.54345	-0.60982	0.362319
11	181.1594	64.43299	1.811594	0.503048	-0.68707	0.241546
12	169.5652	62.90323	1.695652	0.470726	-0.75348	0.193237
13	157.971	61.23596	1.57971	0.438404	-0.82462	0.193237
14	149.2754	59.88372	1.492754	0.414162	-0.8815	0.144928
15	140.5797	58.43373	1.405797	0.38992	-0.94181	0.144928
16	133.3333	57.14286	1.333333	0.369719	-0.99501	0.120773
17	124.2029	55.39754	1.242029	0.344266	-1.06634	0.152174
18	108.6957	52.08333	1.086957	0.301035	-1.20053	0.258454
19	101.4493	50.35971	1.014493	0.280833	-1.26999	0.120773
20	95.65217	48.88889	0.956522	0.264672	-1.32926	0.096618
21	89.85507	47.32824	0.898551	0.248511	-1.39227	0.096618
22	84.05797	45.66929	0.84058	0.23235	-1.45951	0.096618
23	78.26087	43.90244	0.782609	0.216189	-1.5316	0.096618
24	72.46377	42.01681	0.724638	0.200028	-1.6093	0.096618
25	66.66667	40	0.666667	0.183867	-1.69354	0.096618
26	60.86957	37.83784	0.608696	0.167706	-1.78554	0.096618
27	55.07246	35.51402	0.550725	0.151545	-1.88687	0.096618
28	52.17391	34.28571	0.521739	0.143465	-1.94167	0.048309
29	49.27536	33.00971	0.492754	0.135384	-1.99964	0.048309
30	46.37681	31.68317	0.463768	0.127303	-2.06118	0.048309
31	43.47826	30.30303	0.434783	0.119223	-2.12676	0.048309
32	40.57971	28.86598	0.405797	0.111142	-2.19694	0.048309
33	37.68116	27.36842	0.376812	0.103062	-2.27243	0.048309
34	33.33333	25	0.333333	0.090941	-2.39754	0.072464
35	30.43478	23.33333	0.304348	0.082861	-2.4906	0.048309
36	27.53623	21.59091	0.275362	0.07478	-2.5932	0.048309
37	24.63768	19.76744	0.246377	0.0667	-2.70756	0.048309
38	21.73913	17.85714	0.217391	0.058619	-2.8367	0.048309
39	20.28986	16.86747	0.202899	0.054579	-2.90811	0.024155
40	17.3913	14.81481	0.173913	0.046498	-3.06834	0.048309
41	14.49275	12.65823	0.144928	0.038418	-3.25924	0.048309
42	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
43	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
44	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
45	8.695652	8	0.086957	0.022257	-3.80511	0.024155
46	7.246377	6.756757	0.072464	0.018216	-4.00543	0.024155
47	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
48	5.942029	5.608755	0.05942	0.01458	-4.22809	0.009662
49	5.507246	5.21978	0.055072	0.013368	-4.31488	0.007246
50	5.072464	4.827586	0.050725	0.012156	-4.40993	0.007246
51	4.782609	4.564315	0.047826	0.011348	-4.47872	0.004831
52	4.492754	4.299584	0.044928	0.01054	-4.55259	0.004831
53	4.347826	4.166667	0.043478	0.010136	-4.59167	0.002415
54	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
55	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
56	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
57	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
58	3.768116	3.631285	0.037681	0.00852	-4.76536	0

59	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
60	3.623188	3.496503	0.036232	0.008116	-4.81395	0
61	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 3)

15(0.2%)	IMC	78.43					
	Dry Matter	21.57					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.69024		
	EMC	0.714					
	70						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.2	363.7681	78.4375	3.637681	1.012121	0	
2	2.91	321.7391	76.28866	3.217391	0.894953	-0.11098	0.700483
3	2.737	296.6667	74.78992	2.966667	0.825057	-0.1923	0.417874
4	2.604	277.3913	73.5023	2.773913	0.771321	-0.25965	0.321256
5	2.464	257.1014	71.99675	2.571014	0.714758	-0.33581	0.338164
6	2.373	243.913	70.92288	2.43913	0.677991	-0.38862	0.219807
7	2.254	226.6667	69.38776	2.266667	0.629912	-0.46218	0.28744
8	2.121	207.3913	67.46818	2.073913	0.576177	-0.55134	0.321256
9	2.037	195.2174	66.12666	1.952174	0.542238	-0.61205	0.202899
10	1.904	175.942	63.7605	1.75942	0.488503	-0.71641	0.321256
11	1.827	164.7826	62.23317	1.647826	0.457393	-0.78221	0.18599
12	1.743	152.6087	60.41308	1.526087	0.423455	-0.85931	0.202899
13	1.7	146.3768	59.41176	1.463768	0.406082	-0.9012	0.103865
14	1.64	137.6812	57.92683	1.376812	0.38184	-0.96275	0.144928
15	1.56	126.087	55.76923	1.26087	0.349518	-1.0512	0.193237
16	1.48	114.4928	53.37838	1.144928	0.317196	-1.14824	0.193237
17	1.4	102.8986	50.71429	1.028986	0.284874	-1.25571	0.193237
18	1.34	94.2029	48.50746	0.942029	0.260632	-1.34465	0.144928
19	1.28	85.50725	46.09375	0.855072	0.236391	-1.44227	0.144928
20	1.22	76.81159	43.44262	0.768116	0.212149	-1.55047	0.144928
21	1.16	68.11594	40.51724	0.681159	0.187907	-1.67181	0.144928
22	1.1	59.42029	37.27273	0.594203	0.163666	-1.80993	0.144928
23	1.04	50.72464	33.65385	0.507246	0.139424	-1.97023	0.144928
24	0.98	42.02899	29.59184	0.42029	0.115183	-2.16124	0.144928
25	0.94	36.23188	26.59574	0.362319	0.099022	-2.31242	0.096618
26	0.9	30.43478	23.33333	0.304348	0.082861	-2.4906	0.096618
27	0.86	24.63768	19.76744	0.246377	0.0667	-2.70756	0.096618
28	0.82	18.84058	15.85366	0.188406	0.050539	-2.98502	0.096618
29	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.096618
30	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
31	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
32	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.024155
33	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
34	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
35	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
36	0.73	5.797101	5.479452	0.057971	0.014176	-4.25619	0.012077

37	0.725	5.072464	4.827586	0.050725	0.012156	-4.40993	0.012077
38	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.009662
39	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.007246
40	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.004831
41	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
42	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 1)

30(0.05%)	IMC	78.5					
	Dry Matter	21.5					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.69015		
	EMC	0.714					
	50						
Time (h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.21	365.2174	78.50467	3.652174	1.016161	0	
2	3.09	347.8261	77.6699	3.478261	0.967678	-0.03286	0.289855
3	2.99	333.3333	76.92308	3.333333	0.927275	-0.0755	0.241546
4	2.89	318.8406	76.12457	3.188406	0.886873	-0.12005	0.241546
5	2.79	304.3478	75.26882	3.043478	0.84647	-0.16668	0.241546
6	2.7	291.3043	74.44444	2.913043	0.810108	-0.21059	0.217391
7	2.62	279.7101	73.66412	2.797101	0.777786	-0.2513	0.193237
8	2.54	268.1159	72.83465	2.681159	0.745464	-0.29375	0.193237
9	2.43	252.1739	71.60494	2.521739	0.701021	-0.35522	0.2657
10	2.31	234.7826	70.12987	2.347826	0.652537	-0.42689	0.289855
11	2.25	226.087	69.33333	2.26087	0.628296	-0.46474	0.144928
12	2.19	217.3913	68.49315	2.173913	0.604054	-0.50409	0.144928
13	2.14	210.1449	67.75701	2.101449	0.583853	-0.53811	0.120773
14	2.09	202.8986	66.98565	2.028986	0.563652	-0.57332	0.120773
15	2.04	195.6522	66.17647	1.956522	0.54345	-0.60982	0.120773
16	2	189.8551	65.5	1.898551	0.527289	-0.64001	0.096618
17	1.96	184.058	64.79592	1.84058	0.511128	-0.67113	0.096618
18	1.92	178.2609	64.0625	1.782609	0.494967	-0.70326	0.096618
19	1.81	162.3188	61.87845	1.623188	0.450524	-0.79734	0.2657
20	1.77	156.5217	61.01695	1.565217	0.434363	-0.83387	0.096618
21	1.73	150.7246	60.11561	1.507246	0.418202	-0.87179	0.096618
22	1.69	144.9275	59.1716	1.449275	0.402041	-0.9112	0.096618
23	1.64	137.6812	57.92683	1.376812	0.38184	-0.96275	0.120773
24	1.6	131.8841	56.875	1.318841	0.365679	-1.006	0.096618
25	1.56	126.087	55.76923	1.26087	0.349518	-1.0512	0.096618
26	1.52	120.2899	54.60526	1.202899	0.333357	-1.09854	0.096618
27	1.48	114.4928	53.37838	1.144928	0.317196	-1.14824	0.096618
28	1.44	108.6957	52.08333	1.086957	0.301035	-1.20053	0.096618
29	1.39	101.4493	50.35971	1.014493	0.280833	-1.26999	0.120773
30	1.35	95.65217	48.88889	0.956522	0.264672	-1.32926	0.096618
31	1.31	89.85507	47.32824	0.898551	0.248511	-1.39227	0.096618
32	1.29	86.95652	46.51163	0.869565	0.240431	-1.42532	0.048309
33	1.27	84.05797	45.66929	0.84058	0.23235	-1.45951	0.048309

34	1.25	81.15942	44.8	0.811594	0.22427	-1.49491	0.048309
35	1.21	75.36232	42.97521	0.753623	0.208109	-1.56969	0.096618
36	1.19	72.46377	42.01681	0.724638	0.200028	-1.6093	0.048309
37	1.17	69.56522	41.02564	0.695652	0.191948	-1.65053	0.048309
38	1.15	66.66667	40	0.666667	0.183867	-1.69354	0.048309
39	1.13	63.76812	38.93805	0.637681	0.175787	-1.73848	0.048309
40	1.11	60.86957	37.83784	0.608696	0.167706	-1.78554	0.048309
41	1.07	55.07246	35.51402	0.550725	0.151545	-1.88687	0.096618
42	1.05	52.17391	34.28571	0.521739	0.143465	-1.94167	0.048309
43	1.03	49.27536	33.00971	0.492754	0.135384	-1.99964	0.048309
44	1.01	46.37681	31.68317	0.463768	0.127303	-2.06118	0.048309
45	0.99	43.47826	30.30303	0.434783	0.119223	-2.12676	0.048309
46	0.98	42.02899	29.59184	0.42029	0.115183	-2.16124	0.024155
47	0.96	39.13043	28.125	0.391304	0.107102	-2.23397	0.048309
48	0.95	37.68116	27.36842	0.376812	0.103062	-2.27243	0.024155
49	0.94	36.23188	26.59574	0.362319	0.099022	-2.31242	0.024155
50	0.93	34.78261	25.80645	0.347826	0.094981	-2.35407	0.024155
51	0.92	33.33333	25	0.333333	0.090941	-2.39754	0.024155
52	0.91	31.88406	24.17582	0.318841	0.086901	-2.44299	0.024155
53	0.89	28.98551	22.47191	0.289855	0.07882	-2.54058	0.048309
54	0.88	27.53623	21.59091	0.275362	0.07478	-2.5932	0.024155
55	0.87	26.08696	20.68966	0.26087	0.07074	-2.64875	0.024155
56	0.86	24.63768	19.76744	0.246377	0.0667	-2.70756	0.024155
57	0.85	23.18841	18.82353	0.231884	0.062659	-2.77004	0.024155
58	0.84	21.73913	17.85714	0.217391	0.058619	-2.8367	0.024155
59	0.83	20.28986	16.86747	0.202899	0.054579	-2.90811	0.024155
60	0.82	18.84058	15.85366	0.188406	0.050539	-2.98502	0.024155
61	0.81	17.3913	14.81481	0.173913	0.046498	-3.06834	0.024155
62	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.024155
63	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
64	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
65	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
66	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
67	0.755	9.42029	8.609272	0.094203	0.024277	-3.71823	0.012077
68	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.012077
69	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
70	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
71	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
72	0.731	5.942029	5.608755	0.05942	0.01458	-4.22809	0.009662
73	0.729	5.652174	5.349794	0.056522	0.013772	-4.28511	0.004831
74	0.726	5.217391	4.958678	0.052174	0.01256	-4.37723	0.007246
75	0.724	4.927536	4.696133	0.049275	0.011752	-4.44373	0.004831
76	0.722	4.637681	4.432133	0.046377	0.010944	-4.51497	0.004831
77	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.002415
78	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.002415
79	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
80	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
81	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0
82	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
83	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0
84	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
85	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0

86	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
87	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
88	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 2)

30(0.05%)	IMC	78.5					
	Dry Matter	21.5					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.69015		
	EMC	0.714					
	60						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.21	365.2174	78.50467	3.652174	1.016161	0	
2	3.03	339.1304	77.22772	3.391304	0.943436	-0.05823	0.434783
3	2.97	330.4348	76.76768	3.304348	0.919195	-0.08426	0.144928
4	2.82	308.6957	75.53191	3.086957	0.858591	-0.15246	0.362319
5	2.76	300	75	3	0.834349	-0.1811	0.144928
6	2.62	279.7101	73.66412	2.797101	0.777786	-0.2513	0.338164
7	2.51	263.7681	72.50996	2.637681	0.733343	-0.31014	0.2657
8	2.39	246.3768	71.12971	2.463768	0.68486	-0.37854	0.289855
9	2.28	230.4348	69.73684	2.304348	0.640417	-0.44564	0.2657
10	2.16	213.0435	68.05556	2.130435	0.591934	-0.52436	0.289855
11	2.05	197.1014	66.34146	1.971014	0.547491	-0.60241	0.2657
12	1.95	182.6087	64.61538	1.826087	0.507088	-0.67907	0.241546
13	1.84	166.6667	62.5	1.666667	0.462645	-0.77079	0.2657
14	1.71	147.8261	59.64912	1.478261	0.410122	-0.8913	0.31401
15	1.66	140.5797	58.43373	1.405797	0.38992	-0.94181	0.120773
16	1.57	127.5362	56.05096	1.275362	0.353558	-1.03971	0.217391
17	1.49	115.942	53.69128	1.15942	0.321236	-1.13558	0.193237
18	1.41	104.3478	51.06383	1.043478	0.288914	-1.24163	0.193237
19	1.26	82.6087	45.2381	0.826087	0.22831	-1.47705	0.362319
20	1.2	73.91304	42.5	0.73913	0.204068	-1.5893	0.144928
21	1.15	66.66667	40	0.666667	0.183867	-1.69354	0.120773
22	1.1	59.42029	37.27273	0.594203	0.163666	-1.80993	0.120773
23	1.06	53.62319	34.90566	0.536232	0.147505	-1.91389	0.096618
24	1.02	47.82609	32.35294	0.478261	0.131344	-2.02994	0.096618
25	0.98	42.02899	29.59184	0.42029	0.115183	-2.16124	0.096618
26	0.94	36.23188	26.59574	0.362319	0.099022	-2.31242	0.096618
27	0.92	33.33333	25	0.333333	0.090941	-2.39754	0.048309
28	0.9	30.43478	23.33333	0.304348	0.082861	-2.4906	0.048309
29	0.88	27.53623	21.59091	0.275362	0.07478	-2.5932	0.048309
30	0.86	24.63768	19.76744	0.246377	0.0667	-2.70756	0.048309
31	0.84	21.73913	17.85714	0.217391	0.058619	-2.8367	0.048309
32	0.82	18.84058	15.85366	0.188406	0.050539	-2.98502	0.048309
33	0.81	17.3913	14.81481	0.173913	0.046498	-3.06834	0.024155
34	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.024155
35	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
36	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155

37	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
38	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
39	0.755	9.42029	8.609272	0.094203	0.024277	-3.71823	0.012077
40	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.012077
41	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
42	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
43	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
44	0.728	5.507246	5.21978	0.055072	0.013368	-4.31488	0.016908
45	0.725	5.072464	4.827586	0.050725	0.012156	-4.40993	0.007246
46	0.723	4.782609	4.564315	0.047826	0.011348	-4.47872	0.004831
47	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.004831
48	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.002415
49	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
50	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
51	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
52	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
53	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
54	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
55	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
56	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 3)

30(0.05%)	IMC	78.5					
	Dry Matter	21.5					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.69015		
	EMC	0.714					
	70						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.21	365.2174	78.50467	3.652174	1.016161	0	
2	3	334.7826	77	3.347826	0.931316	-0.07116	0.507246
3	2.89	318.8406	76.12457	3.188406	0.886873	-0.12005	0.2657
4	2.79	304.3478	75.26882	3.043478	0.84647	-0.16668	0.241546
5	2.562	271.3043	73.06792	2.713043	0.754352	-0.2819	0.550725
6	2.43	252.1739	71.60494	2.521739	0.701021	-0.35522	0.318841
7	2.26	227.5362	69.46903	2.275362	0.632336	-0.45833	0.410628
8	2.086	202.3188	66.92234	2.023188	0.562036	-0.57619	0.42029
9	1.97	185.5072	64.97462	1.855072	0.515169	-0.66326	0.280193
10	1.869	170.8696	63.08186	1.708696	0.474362	-0.74578	0.243961
11	1.74	152.1739	60.34483	1.521739	0.422243	-0.86218	0.311594
12	1.66	140.5797	58.43373	1.405797	0.38992	-0.94181	0.193237
13	1.55	124.6377	55.48387	1.246377	0.345478	-1.06283	0.2657
14	1.46	111.5942	52.73973	1.115942	0.309115	-1.17404	0.217391
15	1.39	101.4493	50.35971	1.014493	0.280833	-1.26999	0.169082
16	1.27	84.05797	45.66929	0.84058	0.23235	-1.45951	0.289855

17	1.17	69.56522	41.02564	0.695652	0.191948	-1.65053	0.241546
18	1.07	55.07246	35.51402	0.550725	0.151545	-1.88687	0.241546
19	0.99	43.47826	30.30303	0.434783	0.119223	-2.12676	0.193237
20	0.91	31.88406	24.17582	0.318841	0.086901	-2.44299	0.193237
21	0.86	24.63768	19.76744	0.246377	0.0667	-2.70756	0.120773
22	0.84	21.73913	17.85714	0.217391	0.058619	-2.8367	0.048309
23	0.82	18.84058	15.85366	0.188406	0.050539	-2.98502	0.048309
24	0.81	17.3913	14.81481	0.173913	0.046498	-3.06834	0.024155
25	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.024155
26	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
27	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
28	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
29	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
30	0.755	9.42029	8.609272	0.094203	0.024277	-3.71823	0.012077
31	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.012077
32	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
33	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
34	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
35	0.73	5.797101	5.479452	0.057971	0.014176	-4.25619	0.012077
36	0.725	5.072464	4.827586	0.050725	0.012156	-4.40993	0.012077
37	0.723	4.782609	4.564315	0.047826	0.011348	-4.47872	0.004831
38	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.009662
39	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.004831
40	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.004831
41	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 1)

30(0.1%)	IMC	78.63					
	Dry Matter	21.37					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.690251		
	EMC	0.714					
	50						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.23	368.1159	78.63777	3.681159	1.024242	0	
2	3.08	346.3768	77.5974	3.463768	0.963638	-0.03704	0.362319
3	2.98	331.8841	76.84564	3.318841	0.923235	-0.07987	0.241546
4	2.88	317.3913	76.04167	3.173913	0.882832	-0.12462	0.241546
5	2.78	302.8986	75.17986	3.028986	0.84243	-0.17146	0.241546
6	2.69	289.8551	74.34944	2.898551	0.806067	-0.21559	0.217391
7	2.61	278.2609	73.56322	2.782609	0.773745	-0.25651	0.193237
8	2.53	266.6667	72.72727	2.666667	0.741423	-0.29918	0.193237
9	2.42	250.7246	71.4876	2.507246	0.69698	-0.361	0.2657

10	2.3	233.3333	70	2.333333	0.648497	-0.4331	0.289855
11	2.24	224.6377	69.19643	2.246377	0.624256	-0.4712	0.144928
12	2.18	215.942	68.34862	2.15942	0.600014	-0.5108	0.144928
13	2.13	208.6957	67.60563	2.086957	0.579813	-0.54505	0.120773
14	2.08	201.4493	66.82692	2.014493	0.559611	-0.58051	0.120773
15	2.03	194.2029	66.00985	1.942029	0.53941	-0.61728	0.120773
16	1.99	188.4058	65.32663	1.884058	0.523249	-0.6477	0.096618
17	1.95	182.6087	64.61538	1.826087	0.507088	-0.67907	0.096618
18	1.91	176.8116	63.87435	1.768116	0.490927	-0.71146	0.096618
19	1.8	160.8696	61.66667	1.608696	0.446484	-0.80635	0.2657
20	1.76	155.0725	60.79545	1.550725	0.430323	-0.84322	0.096618
21	1.72	149.2754	59.88372	1.492754	0.414162	-0.8815	0.096618
22	1.68	143.4783	58.92857	1.434783	0.398001	-0.9213	0.096618
23	1.63	136.2319	57.66871	1.362319	0.3778	-0.97339	0.120773
24	1.59	130.4348	56.60377	1.304348	0.361639	-1.01711	0.096618
25	1.55	124.6377	55.48387	1.246377	0.345478	-1.06283	0.096618
26	1.51	118.8406	54.30464	1.188406	0.329317	-1.11074	0.096618
27	1.47	113.0435	53.06122	1.130435	0.313156	-1.16106	0.096618
28	1.43	107.2464	51.74825	1.072464	0.296994	-1.21404	0.096618
29	1.38	100	50	1	0.276793	-1.28448	0.120773
30	1.34	94.2029	48.50746	0.942029	0.260632	-1.34465	0.096618
31	1.3	88.4058	46.92308	0.884058	0.244471	-1.40866	0.096618
32	1.28	85.50725	46.09375	0.855072	0.236391	-1.44227	0.048309
33	1.26	82.6087	45.2381	0.826087	0.22831	-1.47705	0.048309
34	1.24	79.71014	44.35484	0.797101	0.220229	-1.51309	0.048309
35	1.2	73.91304	42.5	0.73913	0.204068	-1.5893	0.096618
36	1.18	71.01449	41.52542	0.710145	0.195988	-1.6297	0.048309
37	1.16	68.11594	40.51724	0.681159	0.187907	-1.67181	0.048309
38	1.14	65.21739	39.47368	0.652174	0.179827	-1.71576	0.048309
39	1.12	62.31884	38.39286	0.623188	0.171746	-1.76174	0.048309
40	1.1	59.42029	37.27273	0.594203	0.163666	-1.80993	0.048309
41	1.06	53.62319	34.90566	0.536232	0.147505	-1.91389	0.096618
42	1.04	50.72464	33.65385	0.507246	0.139424	-1.97023	0.048309
43	1.02	47.82609	32.35294	0.478261	0.131344	-2.02994	0.048309
44	1	44.92754	31	0.449275	0.123263	-2.09343	0.048309
45	0.98	42.02899	29.59184	0.42029	0.115183	-2.16124	0.048309
46	0.97	40.57971	28.86598	0.405797	0.111142	-2.19694	0.024155
47	0.95	37.68116	27.36842	0.376812	0.103062	-2.27243	0.048309
48	0.95	37.68116	27.36842	0.376812	0.103062	-2.27243	0
49	0.93	34.78261	25.80645	0.347826	0.094981	-2.35407	0.048309
50	0.92	33.33333	25	0.333333	0.090941	-2.39754	0.024155
51	0.91	31.88406	24.17582	0.318841	0.086901	-2.44299	0.024155
52	0.9	30.43478	23.33333	0.304348	0.082861	-2.4906	0.024155
53	0.88	27.53623	21.59091	0.275362	0.07478	-2.5932	0.048309
54	0.87	26.08696	20.68966	0.26087	0.07074	-2.64875	0.024155
55	0.86	24.63768	19.76744	0.246377	0.0667	-2.70756	0.024155
56	0.85	23.18841	18.82353	0.231884	0.062659	-2.77004	0.024155
57	0.84	21.73913	17.85714	0.217391	0.058619	-2.8367	0.024155
58	0.83	20.28986	16.86747	0.202899	0.054579	-2.90811	0.024155
59	0.82	18.84058	15.85366	0.188406	0.050539	-2.98502	0.024155
60	0.81	17.3913	14.81481	0.173913	0.046498	-3.06834	0.024155
61	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.024155

62	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
63	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
64	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
65	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
66	0.755	9.42029	8.609272	0.094203	0.024277	-3.71823	0.012077
67	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.012077
68	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
69	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
70	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
71	0.731	5.942029	5.608755	0.05942	0.01458	-4.22809	0.009662
72	0.729	5.652174	5.349794	0.056522	0.013772	-4.28511	0.004831
73	0.726	5.217391	4.958678	0.052174	0.01256	-4.37723	0.007246
74	0.724	4.927536	4.696133	0.049275	0.011752	-4.44373	0.004831
75	0.722	4.637681	4.432133	0.046377	0.010944	-4.51497	0.004831
76	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.002415
77	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.002415
78	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
79	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
80	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0
81	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
82	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0
83	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
84	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
85	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
86	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
87	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 2)

30(0.1%)	IMC	78.63					
	Dry Matter	21.37					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.690251		
	EMC	0.714					
	60						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.23	368.1159	78.63777	3.681159	1.024242	0	
2	3.02	337.6812	77.15232	3.376812	0.939396	-0.06252	0.507246
3	2.96	328.9855	76.68919	3.289855	0.915155	-0.08866	0.144928
4	2.81	307.2464	75.44484	3.072464	0.854551	-0.15718	0.362319
5	2.75	298.5507	74.90909	2.985507	0.830309	-0.18596	0.144928
6	2.61	278.2609	73.56322	2.782609	0.773745	-0.25651	0.338164
7	2.5	262.3188	72.4	2.623188	0.729302	-0.31567	0.2657
8	2.38	244.9275	71.0084	2.449275	0.680819	-0.38446	0.289855
9	2.27	228.9855	69.60352	2.289855	0.636376	-0.45196	0.2657
10	2.16	213.0435	68.05556	2.130435	0.591934	-0.52436	0.2657
11	2.04	195.6522	66.17647	1.956522	0.54345	-0.60982	0.289855
12	1.93	179.7101	64.2487	1.797101	0.499008	-0.69513	0.2657

13	1.82	163.7681	62.08791	1.637681	0.454565	-0.78842	0.2657
14	1.7	146.3768	59.41176	1.463768	0.406082	-0.9012	0.289855
15	1.62	134.7826	57.40741	1.347826	0.373759	-0.98414	0.193237
16	1.54	123.1884	55.19481	1.231884	0.341437	-1.07459	0.193237
17	1.48	114.4928	53.37838	1.144928	0.317196	-1.14824	0.144928
18	1.33	92.75362	48.1203	0.927536	0.256592	-1.36027	0.362319
19	1.25	81.15942	44.8	0.811594	0.22427	-1.49491	0.193237
20	1.19	72.46377	42.01681	0.724638	0.200028	-1.6093	0.144928
21	1.14	65.21739	39.47368	0.652174	0.179827	-1.71576	0.120773
22	1.09	57.97101	36.69725	0.57971	0.159626	-1.83492	0.120773
23	1.05	52.17391	34.28571	0.521739	0.143465	-1.94167	0.096618
24	1.01	46.37681	31.68317	0.463768	0.127303	-2.06118	0.096618
25	0.97	40.57971	28.86598	0.405797	0.111142	-2.19694	0.096618
26	0.93	34.78261	25.80645	0.347826	0.094981	-2.35407	0.096618
27	0.91	31.88406	24.17582	0.318841	0.086901	-2.44299	0.048309
28	0.89	28.98551	22.47191	0.289855	0.07882	-2.54058	0.048309
29	0.87	26.08696	20.68966	0.26087	0.07074	-2.64875	0.048309
30	0.85	23.18841	18.82353	0.231884	0.062659	-2.77004	0.048309
31	0.83	20.28986	16.86747	0.202899	0.054579	-2.90811	0.048309
32	0.81	17.3913	14.81481	0.173913	0.046498	-3.06834	0.048309
33	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.024155
34	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
35	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
36	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
37	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
38	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.024155
39	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
40	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
41	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
42	0.73	5.797101	5.479452	0.057971	0.014176	-4.25619	0.012077
43	0.728	5.507246	5.21978	0.055072	0.013368	-4.31488	0.004831
44	0.725	5.072464	4.827586	0.050725	0.012156	-4.40993	0.007246
45	0.723	4.782609	4.564315	0.047826	0.011348	-4.47872	0.004831
46	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.004831
47	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.002415
48	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
49	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
50	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
51	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
52	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
53	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
54	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
55	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 3)

30(0.1%)	IMC	78.63					
	Dry Matter	21.37					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.690251		
	EMC	0.714					
	70						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.23	368.1159	78.63777	3.681159	1.024242	0	
2	3.01	336.2319	77.07641	3.362319	0.935356	-0.06683	0.531401
3	2.85	313.0435	75.78947	3.130435	0.870712	-0.13844	0.386473
4	2.71	292.7536	74.53875	2.927536	0.814148	-0.20561	0.338164
5	2.62	279.7101	73.66412	2.797101	0.777786	-0.2513	0.217391
6	2.42	250.7246	71.4876	2.507246	0.69698	-0.361	0.483092
7	2.35	240.5797	70.6383	2.405797	0.668699	-0.40242	0.169082
8	2.26	227.5362	69.46903	2.275362	0.632336	-0.45833	0.217391
9	2.15	211.5942	67.90698	2.115942	0.587893	-0.53121	0.2657
10	2.03	194.2029	66.00985	1.942029	0.53941	-0.61728	0.289855
11	1.97	185.5072	64.97462	1.855072	0.515169	-0.66326	0.144928
12	1.71	147.8261	59.64912	1.478261	0.410122	-0.8913	0.628019
13	1.6	131.8841	56.875	1.318841	0.365679	-1.006	0.2657
14	1.51	118.8406	54.30464	1.188406	0.329317	-1.11074	0.217391
15	1.42	105.7971	51.40845	1.057971	0.292954	-1.22774	0.217391
16	1.35	95.65217	48.88889	0.956522	0.264672	-1.32926	0.169082
17	1.28	85.50725	46.09375	0.855072	0.236391	-1.44227	0.169082
18	1.2	73.91304	42.5	0.73913	0.204068	-1.5893	0.193237
19	1.11	60.86957	37.83784	0.608696	0.167706	-1.78554	0.217391
20	1.06	53.62319	34.90566	0.536232	0.147505	-1.91389	0.120773
21	0.97	40.57971	28.86598	0.405797	0.111142	-2.19694	0.217391
22	0.89	28.98551	22.47191	0.289855	0.07882	-2.54058	0.193237
23	0.85	23.18841	18.82353	0.231884	0.062659	-2.77004	0.096618
24	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.144928
25	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
26	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
27	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
28	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.024155
29	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
30	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
31	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
32	0.73	5.797101	5.479452	0.057971	0.014176	-4.25619	0.012077
33	0.726	5.217391	4.958678	0.052174	0.01256	-4.37723	0.009662
34	0.723	4.782609	4.564315	0.047826	0.011348	-4.47872	0.007246
35	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.007246
36	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.007246
37	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
38	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
39	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
40	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 1)

30(0.2%)	IMC	78.7					
	Dry Matter	21.3					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.69012		
	EMC	0.714					
	50						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.24	369.5652	78.7037	3.695652	1.028282	0	
2	3.07	344.9275	77.52443	3.449275	0.959597	-0.04124	0.410628
3	2.97	330.4348	76.76768	3.304348	0.919195	-0.08426	0.241546
4	2.87	315.942	75.95819	3.15942	0.878792	-0.12921	0.241546
5	2.77	301.4493	75.09025	3.014493	0.83839	-0.17627	0.241546
6	2.68	288.4058	74.25373	2.884058	0.802027	-0.22061	0.217391
7	2.6	276.8116	73.46154	2.768116	0.769705	-0.26175	0.193237
8	2.52	265.2174	72.61905	2.652174	0.737383	-0.30465	0.193237
9	2.41	249.2754	71.36929	2.492754	0.69294	-0.36681	0.2657
10	2.29	231.8841	69.869	2.318841	0.644457	-0.43935	0.289855
11	2.23	223.1884	69.0583	2.231884	0.620215	-0.47769	0.144928
12	2.17	214.4928	68.20276	2.144928	0.595974	-0.51756	0.144928
13	2.12	207.2464	67.45283	2.072464	0.575773	-0.55204	0.120773
14	2.07	200	66.66667	2	0.555571	-0.58776	0.120773
15	2.02	192.7536	65.84158	1.927536	0.53537	-0.6248	0.120773
16	1.98	186.9565	65.15152	1.869565	0.519209	-0.65545	0.096618
17	1.913	177.2464	63.931	1.772464	0.492139	-0.70899	0.161836
18	1.858	169.2754	62.86329	1.692754	0.469918	-0.7552	0.13285
19	1.79	159.4203	61.45251	1.594203	0.442444	-0.81544	0.164251
20	1.75	153.6232	60.57143	1.536232	0.426283	-0.85265	0.096618
21	1.71	147.8261	59.64912	1.478261	0.410122	-0.8913	0.096618
22	1.67	142.029	58.68263	1.42029	0.393961	-0.9315	0.096618
23	1.62	134.7826	57.40741	1.347826	0.373759	-0.98414	0.120773
24	1.58	128.9855	56.32911	1.289855	0.357598	-1.02834	0.096618
25	1.54	123.1884	55.19481	1.231884	0.341437	-1.07459	0.096618
26	1.5	117.3913	54	1.173913	0.325276	-1.12308	0.096618
27	1.46	111.5942	52.73973	1.115942	0.309115	-1.17404	0.096618
28	1.42	105.7971	51.40845	1.057971	0.292954	-1.22774	0.096618
29	1.37	98.55072	49.63504	0.985507	0.272753	-1.29919	0.120773
30	1.33	92.75362	48.1203	0.927536	0.256592	-1.36027	0.096618
31	1.29	86.95652	46.51163	0.869565	0.240431	-1.42532	0.096618
32	1.27	84.05797	45.66929	0.84058	0.23235	-1.45951	0.048309
33	1.25	81.15942	44.8	0.811594	0.22427	-1.49491	0.048309
34	1.23	78.26087	43.90244	0.782609	0.216189	-1.5316	0.048309
35	1.19	72.46377	42.01681	0.724638	0.200028	-1.6093	0.096618
36	1.17	69.56522	41.02564	0.695652	0.191948	-1.65053	0.048309
37	1.15	66.66667	40	0.666667	0.183867	-1.69354	0.048309
38	1.13	63.76812	38.93805	0.637681	0.175787	-1.73848	0.048309
39	1.11	60.86957	37.83784	0.608696	0.167706	-1.78554	0.048309
40	1.09	57.97101	36.69725	0.57971	0.159626	-1.83492	0.048309
41	1.05	52.17391	34.28571	0.521739	0.143465	-1.94167	0.096618

42	1.03	49.27536	33.00971	0.492754	0.135384	-1.99964	0.048309
43	1.01	46.37681	31.68317	0.463768	0.127303	-2.06118	0.048309
44	0.99	43.47826	30.30303	0.434783	0.119223	-2.12676	0.048309
45	0.97	40.57971	28.86598	0.405797	0.111142	-2.19694	0.048309
46	0.96	39.13043	28.125	0.391304	0.107102	-2.23397	0.024155
47	0.94	36.23188	26.59574	0.362319	0.099022	-2.31242	0.048309
48	0.929	34.63768	25.72659	0.346377	0.094577	-2.35834	0.02657
49	0.92	33.33333	25	0.333333	0.090941	-2.39754	0.021739
50	0.91	31.88406	24.17582	0.318841	0.086901	-2.44299	0.024155
51	0.9	30.43478	23.33333	0.304348	0.082861	-2.4906	0.024155
52	0.89	28.98551	22.47191	0.289855	0.07882	-2.54058	0.024155
53	0.87	26.08696	20.68966	0.26087	0.07074	-2.64875	0.048309
54	0.86	24.63768	19.76744	0.246377	0.0667	-2.70756	0.024155
55	0.85	23.18841	18.82353	0.231884	0.062659	-2.77004	0.024155
56	0.84	21.73913	17.85714	0.217391	0.058619	-2.8367	0.024155
57	0.83	20.28986	16.86747	0.202899	0.054579	-2.90811	0.024155
58	0.82	18.84058	15.85366	0.188406	0.050539	-2.98502	0.024155
59	0.81	17.3913	14.81481	0.173913	0.046498	-3.06834	0.024155
60	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.024155
61	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
62	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
63	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
64	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
65	0.755	9.42029	8.609272	0.094203	0.024277	-3.71823	0.012077
66	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.012077
67	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
68	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
69	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
70	0.731	5.942029	5.608755	0.05942	0.01458	-4.22809	0.009662
71	0.729	5.652174	5.349794	0.056522	0.013772	-4.28511	0.004831
72	0.726	5.217391	4.958678	0.052174	0.01256	-4.37723	0.007246
73	0.724	4.927536	4.696133	0.049275	0.011752	-4.44373	0.004831
74	0.722	4.637681	4.432133	0.046377	0.010944	-4.51497	0.004831
75	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.002415
76	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.002415
77	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
78	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
79	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0
80	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
81	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0
82	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
83	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
84	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
85	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
86	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 2)

30(0.2%)	IMC	78.7					
	Dry Matter	21.3					
	Wt. of DM	Initial Mass of Sample × (DM%/100)		0.69012			
	EMC	0.714					
	60						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.24	369.5652	78.7037	3.695652	1.028282	0	
2	3.01	336.2319	77.07641	3.362319	0.935356	-0.06683	0.555556
3	2.95	327.5362	76.61017	3.275362	0.911114	-0.09309	0.144928
4	2.8	305.7971	75.35714	3.057971	0.85051	-0.16192	0.362319
5	2.74	297.1014	74.81752	2.971014	0.826269	-0.19084	0.144928
6	2.571	272.6087	73.16219	2.726087	0.757988	-0.27709	0.408213
7	2.49	260.8696	72.28916	2.608696	0.725262	-0.32122	0.195652
8	2.37	243.4783	70.88608	2.434783	0.676779	-0.39041	0.289855
9	2.26	227.5362	69.46903	2.275362	0.632336	-0.45833	0.2657
10	2.14	210.1449	67.75701	2.101449	0.583853	-0.53811	0.289855
11	2.044	196.2319	66.24266	1.962319	0.545067	-0.60685	0.231884
12	1.98	186.9565	65.15152	1.869565	0.519209	-0.65545	0.154589
13	1.88	172.4638	63.29787	1.724638	0.478806	-0.73646	0.241546
14	1.77	156.5217	61.01695	1.565217	0.434363	-0.83387	0.2657
15	1.69	144.9275	59.1716	1.449275	0.402041	-0.9112	0.193237
16	1.53	121.7391	54.90196	1.217391	0.337397	-1.08649	0.386473
17	1.47	113.0435	53.06122	1.130435	0.313156	-1.16106	0.144928
18	1.33	92.75362	48.1203	0.927536	0.256592	-1.36027	0.338164
19	1.25	81.15942	44.8	0.811594	0.22427	-1.49491	0.193237
20	1.18	71.01449	41.52542	0.710145	0.195988	-1.6297	0.169082
21	1.13	63.76812	38.93805	0.637681	0.175787	-1.73848	0.120773
22	1.08	56.52174	36.11111	0.565217	0.155585	-1.86056	0.120773
23	1.04	50.72464	33.65385	0.507246	0.139424	-1.97023	0.096618
24	1	44.92754	31	0.449275	0.123263	-2.09343	0.096618
25	0.96	39.13043	28.125	0.391304	0.107102	-2.23397	0.096618
26	0.92	33.33333	25	0.333333	0.090941	-2.39754	0.096618
27	0.9	30.43478	23.33333	0.304348	0.082861	-2.4906	0.048309
28	0.88	27.53623	21.59091	0.275362	0.07478	-2.5932	0.048309
29	0.86	24.63768	19.76744	0.246377	0.0667	-2.70756	0.048309
30	0.84	21.73913	17.85714	0.217391	0.058619	-2.8367	0.048309
31	0.82	18.84058	15.85366	0.188406	0.050539	-2.98502	0.048309
32	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.048309
33	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
34	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
35	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
36	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
37	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.024155
38	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.024155
39	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
40	0.73	5.797101	5.479452	0.057971	0.014176	-4.25619	0.012077
41	0.725	5.072464	4.827586	0.050725	0.012156	-4.40993	0.012077

42	0.731	5.942029	5.608755	0.05942	0.01458	-4.22809	-0.01449
43	0.728	5.507246	5.21978	0.055072	0.013368	-4.31488	0.007246
44	0.725	5.072464	4.827586	0.050725	0.012156	-4.40993	0.007246
45	0.723	4.782609	4.564315	0.047826	0.011348	-4.47872	0.004831
46	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.004831
47	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.002415
48	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
49	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
50	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
51	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
52	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
53	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
54	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
55	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 3)

30(0.2%)	IMC	78.7					
	Dry Matter	21.3					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.69012		
	EMC	0.714					
	70						

Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.24	369.5652	78.7037	3.695652	1.028282	0	
2	3	334.7826	77	3.347826	0.931316	-0.07116	0.57971
3	2.84	311.5942	75.70423	3.115942	0.866671	-0.1431	0.386473
4	2.7	291.3043	74.44444	2.913043	0.810108	-0.21059	0.338164
5	2.548	269.2754	72.91994	2.692754	0.748696	-0.28942	0.36715
6	2.41	249.2754	71.36929	2.492754	0.69294	-0.36681	0.333333
7	2.29	231.8841	69.869	2.318841	0.644457	-0.43935	0.289855
8	2.165	213.7681	68.12933	2.137681	0.593954	-0.52095	0.301932
9	2.065	199.2754	66.58596	1.992754	0.553551	-0.5914	0.241546
10	1.98	186.9565	65.15152	1.869565	0.519209	-0.65545	0.205314
11	1.86	169.5652	62.90323	1.695652	0.470726	-0.75348	0.289855
12	1.76	155.0725	60.79545	1.550725	0.430323	-0.84322	0.241546
13	1.65	139.1304	58.18182	1.391304	0.38588	-0.95223	0.2657
14	1.55	124.6377	55.48387	1.246377	0.345478	-1.06283	0.241546
15	1.45	110.1449	52.41379	1.101449	0.305075	-1.1872	0.241546
16	1.37	98.55072	49.63504	0.985507	0.272753	-1.29919	0.193237
17	1.28	85.50725	46.09375	0.855072	0.236391	-1.44227	0.217391
18	1.2	73.91304	42.5	0.73913	0.204068	-1.5893	0.193237
19	1.11	60.86957	37.83784	0.608696	0.167706	-1.78554	0.217391
20	1.02	47.82609	32.35294	0.478261	0.131344	-2.02994	0.217391
21	0.98	42.02899	29.59184	0.42029	0.115183	-2.16124	0.096618
22	0.9	30.43478	23.33333	0.304348	0.082861	-2.4906	0.193237
23	0.87	26.08696	20.68966	0.26087	0.07074	-2.64875	0.072464
24	0.82	18.84058	15.85366	0.188406	0.050539	-2.98502	0.120773
25	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.096618

26	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
27	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
28	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.024155
29	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
30	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
31	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
32	0.73	5.797101	5.479452	0.057971	0.014176	-4.25619	0.012077
33	0.725	5.072464	4.827586	0.050725	0.012156	-4.40993	0.012077
34	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.009662
35	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.007246
36	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.004831
37	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
38	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 1)

45(0.05%)	IMC	78.89					
	Dry Matter	21.11					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.677631		
	EMC	0.714					
	50						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.27	373.913	78.89908	3.73913	1.040403	0	
2	3.183	361.3043	78.32234	3.613043	1.005252	0.005239	0.210145
3	3.053	342.4638	77.39928	3.424638	0.952729	-0.04842	0.31401
4	2.924	323.7681	76.40219	3.237681	0.90061	-0.10468	0.311594
5	2.758	299.7101	74.98187	2.997101	0.833541	-0.18207	0.400966
6	2.629	281.0145	73.75428	2.810145	0.781422	-0.24664	0.311594
7	2.52	265.2174	72.61905	2.652174	0.737383	-0.30465	0.263285
8	2.42	250.7246	71.4876	2.507246	0.69698	-0.361	0.241546
9	2.29	231.8841	69.869	2.318841	0.644457	-0.43935	0.31401
10	2.19	217.3913	68.49315	2.173913	0.604054	-0.50409	0.241546
11	2.11	205.7971	67.29858	2.057971	0.571732	-0.55908	0.193237
12	2.027	193.7681	65.95955	1.937681	0.538198	-0.61953	0.200483
13	1.907	176.3768	63.81751	1.763768	0.489715	-0.71393	0.289855
14	1.8	160.8696	61.66667	1.608696	0.446484	-0.80635	0.258454
15	1.75	153.6232	60.57143	1.536232	0.426283	-0.85265	0.120773
16	1.7	146.3768	59.41176	1.463768	0.406082	-0.9012	0.120773
17	1.66	140.5797	58.43373	1.405797	0.38992	-0.94181	0.096618
18	1.588	130.1449	56.54912	1.301449	0.360831	-1.01935	0.173913
19	1.535	122.4638	55.04886	1.224638	0.339417	-1.08053	0.128019
20	1.49	115.942	53.69128	1.15942	0.321236	-1.13558	0.108696
21	1.45	110.1449	52.41379	1.101449	0.305075	-1.1872	0.096618
22	1.39	101.4493	50.35971	1.014493	0.280833	-1.26999	0.144928
23	1.34	94.2029	48.50746	0.942029	0.260632	-1.34465	0.120773

24	1.32	91.30435	47.72727	0.913043	0.252552	-1.37614	0.048309
25	1.28	85.50725	46.09375	0.855072	0.236391	-1.44227	0.096618
26	1.26	82.6087	45.2381	0.826087	0.22831	-1.47705	0.048309
27	1.22	76.81159	43.44262	0.768116	0.212149	-1.55047	0.096618
28	1.18	71.01449	41.52542	0.710145	0.195988	-1.6297	0.096618
29	1.14	65.21739	39.47368	0.652174	0.179827	-1.71576	0.096618
30	1.12	62.31884	38.39286	0.623188	0.171746	-1.76174	0.048309
31	1.08	56.52174	36.11111	0.565217	0.155585	-1.86056	0.096618
32	1.06	53.62319	34.90566	0.536232	0.147505	-1.91389	0.048309
33	1.02	47.82609	32.35294	0.478261	0.131344	-2.02994	0.096618
34	1	44.92754	31	0.449275	0.123263	-2.09343	0.048309
35	0.98	42.02899	29.59184	0.42029	0.115183	-2.16124	0.048309
36	0.96	39.13043	28.125	0.391304	0.107102	-2.23397	0.048309
37	0.94	36.23188	26.59574	0.362319	0.099022	-2.31242	0.048309
38	0.92	33.33333	25	0.333333	0.090941	-2.39754	0.048309
39	0.9	30.43478	23.33333	0.304348	0.082861	-2.4906	0.048309
40	0.88	27.53623	21.59091	0.275362	0.07478	-2.5932	0.048309
41	0.86	24.63768	19.76744	0.246377	0.0667	-2.70756	0.048309
42	0.84	21.73913	17.85714	0.217391	0.058619	-2.8367	0.048309
43	0.82	18.84058	15.85366	0.188406	0.050539	-2.98502	0.048309
44	0.81	17.3913	14.81481	0.173913	0.046498	-3.06834	0.024155
45	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.024155
46	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
47	0.787	14.05797	12.32529	0.14058	0.037206	-3.29129	0.007246
48	0.777	12.6087	11.19691	0.126087	0.033165	-3.40625	0.024155
49	0.772	11.88406	10.62176	0.118841	0.031145	-3.46909	0.012077
50	0.763	10.57971	9.567497	0.105797	0.027509	-3.59324	0.021739
51	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	-0.01691
52	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
53	0.755	9.42029	8.609272	0.094203	0.024277	-3.71823	0.012077
54	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.012077
55	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
56	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
57	0.737	6.811594	6.377205	0.068116	0.017004	-4.07429	0.007246
58	0.734	6.376812	5.99455	0.063768	0.015792	-4.14824	0.007246
59	0.73	5.797101	5.479452	0.057971	0.014176	-4.25619	0.009662
60	0.726	5.217391	4.958678	0.052174	0.01256	-4.37723	0.009662
61	0.722	4.637681	4.432133	0.046377	0.010944	-4.51497	0.009662
62	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.002415
63	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.002415
64	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
65	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
66	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
67	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0
68	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
69	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
70	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
71	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 2)

45(0.05%)	IMC	78.89					
	Dry Matter	21.11					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.677631		
	EMC	0.714					
	60						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.27	373.913	78.89908	3.73913	1.040403	0	
2	3.123	352.6087	77.90586	3.526087	0.981011	-0.01917	0.355072
3	2.945	326.8116	76.57046	3.268116	0.909094	-0.09531	0.429952
4	2.751	298.6957	74.91821	2.986957	0.830713	-0.18547	0.468599
5	2.607	277.8261	73.5328	2.778261	0.772533	-0.25808	0.347826
6	2.47	257.971	72.06478	2.57971	0.717182	-0.33243	0.330918
7	2.326	237.1014	70.33534	2.371014	0.659002	-0.41703	0.347826
8	2.146	211.0145	67.84716	2.110145	0.586277	-0.53396	0.434783
9	2.046	196.5217	66.27566	1.965217	0.545875	-0.60537	0.241546
10	1.9	175.3623	63.68421	1.753623	0.486887	-0.71972	0.352657
11	1.783	158.4058	61.30118	1.584058	0.439616	-0.82185	0.282609
12	1.659	140.4348	58.40868	1.404348	0.389516	-0.94285	0.299517
13	1.535	122.4638	55.04886	1.224638	0.339417	-1.08053	0.299517
14	1.459	111.4493	52.70733	1.114493	0.308711	-1.17535	0.183575
15	1.37	98.55072	49.63504	0.985507	0.272753	-1.29919	0.214976
16	1.27	84.05797	45.66929	0.84058	0.23235	-1.45951	0.241546
17	1.19	72.46377	42.01681	0.724638	0.200028	-1.6093	0.193237
18	1.11	60.86957	37.83784	0.608696	0.167706	-1.78554	0.193237
19	1.03	49.27536	33.00971	0.492754	0.135384	-1.99964	0.193237
20	0.97	40.57971	28.86598	0.405797	0.111142	-2.19694	0.144928
21	0.92	33.33333	25	0.333333	0.090941	-2.39754	0.120773
22	0.87	26.08696	20.68966	0.26087	0.07074	-2.64875	0.120773
23	0.834	20.86957	17.26619	0.208696	0.056195	-2.87893	0.086957
24	0.822	19.13043	16.05839	0.191304	0.051347	-2.96916	0.028986
25	0.821	18.98551	15.95615	0.189855	0.050943	-2.97706	0.002415
26	0.814	17.97101	15.23342	0.17971	0.048114	-3.03417	0.016908
27	0.811	17.53623	14.91985	0.175362	0.046902	-3.05969	0.007246
28	0.814	17.97101	15.23342	0.17971	0.048114	-3.03417	-0.00725
29	0.807	16.95652	14.49814	0.169565	0.045286	-3.09475	0.016908
30	0.796	15.36232	13.31658	0.153623	0.040842	-3.19805	0.02657
31	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.014493
32	0.782	13.33333	11.76471	0.133333	0.035186	-3.34712	0.019324
33	0.763	10.57971	9.567497	0.105797	0.027509	-3.59324	0.045894
34	0.758	9.855072	8.970976	0.098551	0.025489	-3.66951	0.012077
35	0.753	9.130435	8.366534	0.091304	0.023469	-3.75209	0.012077
36	0.749	8.550725	7.87717	0.085507	0.021853	-3.82343	0.009662
37	0.744	7.826087	7.258065	0.078261	0.019833	-3.92043	0.012077
38	0.734	6.376812	5.99455	0.063768	0.015792	-4.14824	0.024155
39	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.036232

40	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
41	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
42	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
43	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
44	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
45	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
46	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 3)

45(0.05%)	IMC	78.89					
	Dry Matter	21.11					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.677631		
	EMC	0.714					
	70						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.27	373.913	78.89908	3.73913	1.040403	0	
2	3.03	339.1304	77.22772	3.391304	0.943436	-0.05823	0.57971
3	2.751	298.6957	74.91821	2.986957	0.830713	-0.18547	0.673913
4	2.557	270.5797	73.01525	2.705797	0.752332	-0.28458	0.468599
5	2.4	247.8261	71.25	2.478261	0.6889	-0.37266	0.379227
6	2.261	227.6812	69.48253	2.276812	0.63274	-0.4577	0.335749
7	2.06	198.5507	66.50485	1.985507	0.551531	-0.59506	0.485507
8	1.94	181.1594	64.43299	1.811594	0.503048	-0.68707	0.289855
9	1.82	163.7681	62.08791	1.637681	0.454565	-0.78842	0.289855
10	1.7	146.3768	59.41176	1.463768	0.406082	-0.9012	0.289855
11	1.556	125.5072	55.65553	1.255072	0.347902	-1.05584	0.347826
12	1.455	110.8696	52.57732	1.108696	0.307095	-1.1806	0.243961
13	1.347	95.21739	48.77506	0.952174	0.26346	-1.33385	0.26087
14	1.224	77.3913	43.62745	0.773913	0.213765	-1.54288	0.297101
15	1.138	64.92754	39.36731	0.649275	0.179019	-1.72026	0.207729
16	1.051	52.31884	34.34824	0.523188	0.143869	-1.93886	0.210145
17	0.98	42.02899	29.59184	0.42029	0.115183	-2.16124	0.171498
18	0.936	35.65217	26.28205	0.356522	0.097406	-2.32887	0.10628
19	0.871	26.23188	20.78071	0.262319	0.071144	-2.64305	0.157005
20	0.814	17.97101	15.23342	0.17971	0.048114	-3.03417	0.137681
21	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.033816
22	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.048309
23	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
24	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
25	0.755	9.42029	8.609272	0.094203	0.024277	-3.71823	0.012077
26	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.024155
27	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
28	0.736	6.666667	6.25	0.066667	0.0166	-4.09833	0.009662
29	0.73	5.797101	5.479452	0.057971	0.014176	-4.25619	0.014493
30	0.729	5.652174	5.349794	0.056522	0.013772	-4.28511	0.002415
31	0.724	4.927536	4.696133	0.049275	0.011752	-4.44373	0.012077
32	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.009662

33	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
34	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
35	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
36	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
37	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
38	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 1)

45(0.1%)	IMC	78.96					
	Dry Matter	21.04					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.675384		
	EMC	0.714					
	50						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.28	375.3623	78.96341	3.753623	1.044443	0	
2	3.137	354.6377	78.00446	3.546377	0.986667	-0.01342	0.345411
3	3	334.7826	77	3.347826	0.931316	-0.07116	0.330918
4	2.85	313.0435	75.78947	3.130435	0.870712	-0.13844	0.362319
5	2.71	292.7536	74.53875	2.927536	0.814148	-0.20561	0.338164
6	2.61	278.2609	73.56322	2.782609	0.773745	-0.25651	0.241546
7	2.47	257.971	72.06478	2.57971	0.717182	-0.33243	0.338164
8	2.36	242.029	70.76271	2.42029	0.672739	-0.3964	0.2657
9	2.28	230.4348	69.73684	2.304348	0.640417	-0.44564	0.193237
10	2.18	215.942	68.34862	2.15942	0.600014	-0.5108	0.241546
11	2.1	204.3478	67.14286	2.043478	0.567692	-0.56618	0.193237
12	2.04	195.6522	66.17647	1.956522	0.54345	-0.60982	0.144928
13	1.94	181.1594	64.43299	1.811594	0.503048	-0.68707	0.241546
14	1.78	157.971	61.23596	1.57971	0.438404	-0.82462	0.386473
15	1.72	149.2754	59.88372	1.492754	0.414162	-0.8815	0.144928
16	1.67	142.029	58.68263	1.42029	0.393961	-0.9315	0.120773
17	1.62	134.7826	57.40741	1.347826	0.373759	-0.98414	0.120773
18	1.58	128.9855	56.32911	1.289855	0.357598	-1.02834	0.096618
19	1.5	117.3913	54	1.173913	0.325276	-1.12308	0.193237
20	1.46	111.5942	52.73973	1.115942	0.309115	-1.17404	0.096618
21	1.42	105.7971	51.40845	1.057971	0.292954	-1.22774	0.096618
22	1.38	100	50	1	0.276793	-1.28448	0.096618
23	1.33	92.75362	48.1203	0.927536	0.256592	-1.36027	0.120773
24	1.31	89.85507	47.32824	0.898551	0.248511	-1.39227	0.048309
25	1.27	84.05797	45.66929	0.84058	0.23235	-1.45951	0.096618
26	1.25	81.15942	44.8	0.811594	0.22427	-1.49491	0.048309
27	1.21	75.36232	42.97521	0.753623	0.208109	-1.56969	0.096618
28	1.17	69.56522	41.02564	0.695652	0.191948	-1.65053	0.096618
29	1.13	63.76812	38.93805	0.637681	0.175787	-1.73848	0.096618
30	1.11	60.86957	37.83784	0.608696	0.167706	-1.78554	0.048309
31	1.07	55.07246	35.51402	0.550725	0.151545	-1.88687	0.096618
32	1.05	52.17391	34.28571	0.521739	0.143465	-1.94167	0.048309
33	1	44.92754	31	0.449275	0.123263	-2.09343	0.120773

34	0.99	43.47826	30.30303	0.434783	0.119223	-2.12676	0.024155
35	0.97	40.57971	28.86598	0.405797	0.111142	-2.19694	0.048309
36	0.95	37.68116	27.36842	0.376812	0.103062	-2.27243	0.048309
37	0.93	34.78261	25.80645	0.347826	0.094981	-2.35407	0.048309
38	0.91	31.88406	24.17582	0.318841	0.086901	-2.44299	0.048309
39	0.89	28.98551	22.47191	0.289855	0.07882	-2.54058	0.048309
40	0.87	26.08696	20.68966	0.26087	0.07074	-2.64875	0.048309
41	0.85	23.18841	18.82353	0.231884	0.062659	-2.77004	0.048309
42	0.83	20.28986	16.86747	0.202899	0.054579	-2.90811	0.048309
43	0.81	17.3913	14.81481	0.173913	0.046498	-3.06834	0.048309
44	0.8	15.94203	13.75	0.15942	0.042458	-3.15924	0.024155
45	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
46	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
47	0.785	13.76812	12.10191	0.137681	0.036398	-3.31325	-0.01208
48	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.012077
49	0.775	12.31884	10.96774	0.123188	0.032357	-3.43091	0.012077
50	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.036232
51	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.024155
52	0.755	9.42029	8.609272	0.094203	0.024277	-3.71823	-0.01208
53	0.75	8.695652	8	0.086957	0.022257	-3.80511	0.012077
54	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
55	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
56	0.736	6.666667	6.25	0.066667	0.0166	-4.09833	0.009662
57	0.733	6.231884	5.866303	0.062319	0.015388	-4.17415	0.007246
58	0.729	5.652174	5.349794	0.056522	0.013772	-4.28511	0.009662
59	0.725	5.072464	4.827586	0.050725	0.012156	-4.40993	0.009662
60	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.009662
61	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.004831
62	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
63	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
64	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0
65	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
66	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
67	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
68	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
69	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 2)

45(0.1%)	IMC	78.96					
	Dry Matter	21.04					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.675384		
	EMC	0.714					
60							
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.28	375.3623	78.96341	3.753623	1.044443	0	
2	3.063	343.913	77.47307	3.43913	0.956769	-0.04419	0.524155
3	2.867	315.5072	75.93303	3.155072	0.87758	-0.13059	0.47343

4	2.665	286.2319	74.10882	2.862319	0.795967	-0.2282	0.487923
5	2.527	266.2319	72.6949	2.662319	0.740211	-0.30082	0.333333
6	2.36	242.029	70.76271	2.42029	0.672739	-0.3964	0.403382
7	2.21	220.2899	68.77828	2.202899	0.612135	-0.4908	0.362319
8	2.07	200	66.66667	2	0.555571	-0.58776	0.338164
9	1.93	179.7101	64.2487	1.797101	0.499008	-0.69513	0.338164
10	1.81	162.3188	61.87845	1.623188	0.450524	-0.79734	0.289855
11	1.7	146.3768	59.41176	1.463768	0.406082	-0.9012	0.2657
12	1.57	127.5362	56.05096	1.275362	0.353558	-1.03971	0.31401
13	1.47	113.0435	53.06122	1.130435	0.313156	-1.16106	0.241546
14	1.36	97.10145	49.26471	0.971014	0.268713	-1.31411	0.2657
15	1.26	82.6087	45.2381	0.826087	0.22831	-1.47705	0.241546
16	1.18	71.01449	41.52542	0.710145	0.195988	-1.6297	0.193237
17	1.1	59.42029	37.27273	0.594203	0.163666	-1.80993	0.193237
18	1.02	47.82609	32.35294	0.478261	0.131344	-2.02994	0.193237
19	0.94	36.23188	26.59574	0.362319	0.099022	-2.31242	0.193237
20	0.88	27.53623	21.59091	0.275362	0.07478	-2.5932	0.144928
21	0.84	21.73913	17.85714	0.217391	0.058619	-2.8367	0.096618
22	0.8	15.94203	13.75000	0.15942	0.042458	-3.15924	0.096618
23	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
24	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
25	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
26	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
27	0.75	8.695652	8.000000	0.086957	0.022257	-3.80511	0.024155
28	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.012077
29	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.024155
30	0.731	5.942029	5.608755	0.05942	0.01458	-4.22809	0.009662
31	0.728	5.507246	5.21978	0.055072	0.013368	-4.31488	0.007246
32	0.725	5.072464	4.827586	0.050725	0.012156	-4.40993	0.007246
33	0.723	4.782609	4.564315	0.047826	0.011348	-4.47872	0.004831
34	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.004831
35	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.002415
36	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
37	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
38	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
39	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
40	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
41	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
42	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
43	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 3)

45(0.1%)	IMC	78.96					
	Dry Matter	21.04					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.675384		
	EMC	0.714					
	70						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.28	375.3623	78.96341	3.753623	1.044443	0	
2	3.01	336.2319	77.07641	3.362319	0.935356	-0.06683	0.652174
3	2.81	307.2464	75.44484	3.072464	0.854551	-0.15718	0.483092
4	2.61	278.2609	73.56322	2.782609	0.773745	-0.25651	0.483092
5	2.45	255.0725	71.83673	2.550725	0.709101	-0.34376	0.386473
6	2.31	234.7826	70.12987	2.347826	0.652537	-0.42689	0.338164
7	2.16	213.0435	68.05556	2.130435	0.591934	-0.52436	0.362319
8	1.87	171.0145	63.1016	1.710145	0.474766	-0.74493	0.700483
9	1.76	155.0725	60.79545	1.550725	0.430323	-0.84322	0.2657
10	1.64	137.6812	57.92683	1.376812	0.38184	-0.96275	0.289855
11	1.46	111.5942	52.73973	1.115942	0.309115	-1.17404	0.434783
12	1.37	98.55072	49.63504	0.985507	0.272753	-1.29919	0.217391
13	1.21	75.36232	42.97521	0.753623	0.208109	-1.56969	0.386473
14	1.15	66.66667	40.00000	0.666667	0.183867	-1.69354	0.144928
15	1.07	55.07246	35.51402	0.550725	0.151545	-1.88687	0.193237
16	1.02	47.82609	32.35294	0.478261	0.131344	-2.02994	0.120773
17	0.97	40.57971	28.86598	0.405797	0.111142	-2.19694	0.120773
18	0.95	37.68116	27.36842	0.376812	0.103062	-2.27243	0.048309
19	0.92	33.33333	25.00000	0.333333	0.090941	-2.39754	0.072464
20	0.898	30.14493	23.16258	0.301449	0.082053	-2.5004	0.05314
21	0.85	23.18841	18.82353	0.231884	0.062659	-2.77004	0.115942
22	0.835	21.01449	17.36527	0.210145	0.056599	-2.87177	0.036232
23	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.13285

24	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
25	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
26	0.745	7.971014	7.38255	0.07971	0.020237	-3.90027	0.036232
27	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
28	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
29	0.729	5.652174	5.349794	0.056522	0.013772	-4.28511	0.014493
30	0.723	4.782609	4.564315	0.047826	0.011348	-4.47872	0.014493
31	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.009662
32	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.004831
33	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.004831
34	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 1)

45(0.2%)	IMC	79.02					
	Dry Matter	20.98					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.673458		
	EMC	0.714					
	50						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.29	376.8116	79.02736	3.768116	1.048483	0	
2	3.177	360.4348	78.2814	3.604348	1.002828	0.002824	0.272947
3	3.046	341.4493	77.34734	3.414493	0.949901	-0.0514	0.316425
4	2.855	313.7681	75.83187	3.137681	0.872732	-0.13613	0.461353
5	2.724	294.7826	74.6696	2.947826	0.819804	-0.19869	0.316425
6	2.58	273.913	73.25581	2.73913	0.761625	-0.2723	0.347826
7	2.467	257.5362	72.03081	2.575362	0.71597	-0.33412	0.272947
8	2.35	240.5797	70.6383	2.405797	0.668699	-0.40242	0.282609
9	2.252	226.3768	69.36057	2.263768	0.629104	-0.46346	0.236715
10	2.17	214.4928	68.20276	2.144928	0.595974	-0.51756	0.198068
11	2.06	198.5507	66.50485	1.985507	0.551531	-0.59506	0.2657
12	1.983	187.3913	65.20424	1.873913	0.520421	-0.65312	0.18599

13	1.9	175.3623	63.68421	1.753623	0.486887	-0.71972	0.200483
14	1.77	156.5217	61.01695	1.565217	0.434363	-0.83387	0.31401
15	1.71	147.8261	59.64912	1.478261	0.410122	-0.8913	0.144928
16	1.66	140.5797	58.43373	1.405797	0.38992	-0.94181	0.120773
17	1.61	133.3333	57.14286	1.333333	0.369719	-0.99501	0.120773
18	1.56	126.087	55.76923	1.26087	0.349518	-1.0512	0.120773
19	1.52	120.2899	54.60526	1.202899	0.333357	-1.09854	0.096618
20	1.45	110.1449	52.41379	1.101449	0.305075	-1.1872	0.169082
21	1.41	104.3478	51.06383	1.043478	0.288914	-1.24163	0.096618
22	1.37	98.55072	49.63504	0.985507	0.272753	-1.29919	0.096618
23	1.32	91.30435	47.72727	0.913043	0.252552	-1.37614	0.120773
24	1.3	88.4058	46.92308	0.884058	0.244471	-1.40866	0.048309
25	1.26	82.6087	45.2381	0.826087	0.22831	-1.47705	0.096618
26	1.24	79.71014	44.35484	0.797101	0.220229	-1.51309	0.048309
27	1.2	73.91304	42.50000	0.73913	0.204068	-1.5893	0.096618
28	1.16	68.11594	40.51724	0.681159	0.187907	-1.67181	0.096618
29	1.12	62.31884	38.39286	0.623188	0.171746	-1.76174	0.096618
30	1.1	59.42029	37.27273	0.594203	0.163666	-1.80993	0.048309
31	1.06	53.62319	34.90566	0.536232	0.147505	-1.91389	0.096618
32	1.04	50.72464	33.65385	0.507246	0.139424	-1.97023	0.048309
33	1	44.92754	31.00000	0.449275	0.123263	-2.09343	0.096618
34	0.98	42.02899	29.59184	0.42029	0.115183	-2.16124	0.048309
35	0.96	39.13043	28.12500	0.391304	0.107102	-2.23397	0.048309
36	0.94	36.23188	26.59574	0.362319	0.099022	-2.31242	0.048309
37	0.92	33.33333	25.00000	0.333333	0.090941	-2.39754	0.048309
38	0.9	30.43478	23.33333	0.304348	0.082861	-2.4906	0.048309
39	0.88	27.53623	21.59091	0.275362	0.07478	-2.5932	0.048309
40	0.86	24.63768	19.76744	0.246377	0.0667	-2.70756	0.048309
41	0.84	21.73913	17.85714	0.217391	0.058619	-2.8367	0.048309
42	0.82	18.84058	15.85366	0.188406	0.050539	-2.98502	0.048309
43	0.8	15.94203	13.75000	0.15942	0.042458	-3.15924	0.048309
44	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.024155
45	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
46	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
47	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
48	0.755	9.42029	8.609272	0.094203	0.024277	-3.71823	0.012077
49	0.75	8.695652	8.000000	0.086957	0.022257	-3.80511	0.012077

50	0.745	7.971014	7.382550	0.07971	0.020237	-3.90027	0.012077
51	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.012077
52	0.737	6.811594	6.377205	0.068116	0.017004	-4.07429	0.007246
53	0.734	6.376812	5.994550	0.063768	0.015792	-4.14824	0.007246
54	0.73	5.797101	5.479452	0.057971	0.014176	-4.25619	0.009662
55	0.726	5.217391	4.958678	0.052174	0.01256	-4.37723	0.009662
56	0.722	4.637681	4.432133	0.046377	0.010944	-4.51497	0.009662
57	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.004831
58	0.719	4.202899	4.033380	0.042029	0.009732	-4.63235	0.002415
59	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
60	0.717	3.913043	3.765690	0.03913	0.008924	-4.71903	0.002415
61	0.717	3.913043	3.765690	0.03913	0.008924	-4.71903	0
62	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
63	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
64	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
65	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
66	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 2)

45(0.2%)	IMC	79.02					
	Dry Matter	20.98					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.673458		
	EMC	0.714					
	60 tem						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.29	376.8116	79.02736	3.768116	1.048483	0	
2	3.106	350.1449	77.78493	3.501449	0.974142	-0.0262	0.444444
3	2.927	324.2029	76.42638	3.242029	0.901822	-0.10334	0.432367
4	2.735	296.3768	74.77148	2.963768	0.824249	-0.19328	0.463768
5	2.538	267.8261	72.81324	2.678261	0.744655	-0.29483	0.475845
6	2.36	242.0290	70.76271	2.42029	0.672739	-0.3964	0.429952
7	2.2	218.8406	68.63636	2.188406	0.608095	-0.49742	0.386473
8	2.06	198.5507	66.50485	1.985507	0.551531	-0.59506	0.338164
9	1.92	178.2609	64.0625	1.782609	0.494967	-0.70326	0.338164
10	1.8	160.8696	61.66667	1.608696	0.446484	-0.80635	0.289855
11	1.648	138.8406	58.13107	1.388406	0.385072	-0.95432	0.36715
12	1.56	126.087	55.76923	1.26087	0.349518	-1.0512	0.21256
13	1.46	111.5942	52.73973	1.115942	0.309115	-1.17404	0.241546
14	1.35	95.65217	48.88889	0.956522	0.264672	-1.32926	0.2657

15	1.25	81.15942	44.80000	0.811594	0.22427	-1.49491	0.241546
16	1.17	69.56522	41.02564	0.695652	0.191948	-1.65053	0.193237
17	1.09	57.97101	36.69725	0.57971	0.159626	-1.83492	0.193237
18	1.01	46.37681	31.68317	0.463768	0.127303	-2.06118	0.193237
19	0.93	34.78261	25.80645	0.347826	0.094981	-2.35407	0.193237
20	0.87	26.08696	20.68966	0.26087	0.07074	-2.64875	0.144928
21	0.83	20.28986	16.86747	0.202899	0.054579	-2.90811	0.096618
22	0.79	14.49275	12.65823	0.144928	0.038418	-3.25924	0.096618
23	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.024155
24	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
25	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
26	0.75	8.695652	8.000000	0.086957	0.022257	-3.80511	0.024155
27	0.745	7.971014	7.382550	0.07971	0.020237	-3.90027	0.012077
28	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.024155
29	0.731	5.942029	5.608755	0.05942	0.01458	-4.22809	0.009662
30	0.728	5.507246	5.21978	0.055072	0.013368	-4.31488	0.007246
31	0.725	5.072464	4.827586	0.050725	0.012156	-4.40993	0.007246
32	0.723	4.782609	4.564315	0.047826	0.011348	-4.47872	0.004831
33	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.004831
34	0.72	4.347826	4.166667	0.043478	0.010136	-4.59167	0.002415
35	0.719	4.202899	4.03338	0.042029	0.009732	-4.63235	0.002415
36	0.718	4.057971	3.899721	0.04058	0.009328	-4.67475	0.002415
37	0.717	3.913043	3.76569	0.03913	0.008924	-4.71903	0.002415
38	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0.002415
39	0.716	3.768116	3.631285	0.037681	0.00852	-4.76536	0
40	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.002415
41	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0
42	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

(Data sheet 3)

45(0.2%)	IMC	79.02					
	Dry Matter	20.98					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.673458		
	EMC	0.714					
	70						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	3.29	376.8116	79.02736	3.768116	1.048483	0	
2	3.058	343.1884	77.43623	3.431884	0.954749	-0.04631	0.560386
3	2.879	317.2464	76.03334	3.172464	0.882428	-0.12508	0.432367
4	2.676	287.8261	74.21525	2.878261	0.800411	-0.22263	0.490338
5	2.45	255.0725	71.83673	2.550725	0.709101	-0.34376	0.545894

6	2.264	228.1159	69.52297	2.281159	0.633952	-0.45578	0.449275
7	2.138	209.8551	67.72685	2.098551	0.583045	-0.53949	0.304348
8	1.959	183.913	64.77795	1.83913	0.510724	-0.67193	0.432367
9	1.81	162.3188	61.87845	1.623188	0.450524	-0.79734	0.359903
10	1.69	144.9275	59.17160	1.449275	0.402041	-0.9112	0.289855
11	1.541	123.3333	55.22388	1.233333	0.341841	-1.07341	0.359903
12	1.445	109.4203	52.24913	1.094203	0.303055	-1.19384	0.231884
13	1.356	96.52174	49.11504	0.965217	0.267097	-1.32015	0.214976
14	1.23	78.26087	43.90244	0.782609	0.216189	-1.5316	0.304348
15	1.153	67.10145	40.15611	0.671014	0.185079	-1.68697	0.18599
16	1.057	53.18841	34.72091	0.531884	0.146293	-1.92215	0.231884
17	0.962	39.42029	28.27443	0.394203	0.10791	-2.22646	0.229469
18	0.896	29.85507	22.99107	0.298551	0.081244	-2.51029	0.15942
19	0.842	22.02899	18.05226	0.22029	0.059427	-2.82301	0.130435
20	0.78	13.04348	11.53846	0.130435	0.034377	-3.37035	0.149758
21	0.77	11.5942	10.38961	0.115942	0.030337	-3.49538	0.024155
22	0.76	10.14493	9.210526	0.101449	0.026297	-3.6383	0.024155
23	0.75	8.695652	8.000000	0.086957	0.022257	-3.80511	0.024155
24	0.74	7.246377	6.756757	0.072464	0.018216	-4.00543	0.024155
25	0.735	6.521739	6.122449	0.065217	0.016196	-4.12297	0.012077
26	0.73	5.797101	5.479452	0.057971	0.014176	-4.25619	0.012077
27	0.725	5.072464	4.827586	0.050725	0.012156	-4.40993	0.012077
28	0.721	4.492754	4.299584	0.044928	0.01054	-4.55259	0.009662
29	0.719	4.202899	4.033380	0.042029	0.009732	-4.63235	0.004831
30	0.717	3.913043	3.765690	0.03913	0.008924	-4.71903	0.004831
31	0.715	3.623188	3.496503	0.036232	0.008116	-4.81395	0.004831
32	0.714	3.478261	3.361345	0.034783	0.007712	-4.86501	0.002415

APPENDIX -E

Vacuume oven treated convective air (Data sheet 1)

1cm cut	IMC	74.85					
	Dry Matter	25.15					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.22635		
	EMC	0.248					
	50tem						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	0.900	297.6143	74.85000	2.976143	0.827699	0	
2	0.86	279.9426	73.68023	2.799426	0.778434	-0.25047	0.294529
3	0.820	262.2708	72.39634	2.622708	0.729169	-0.31585	0.294529
4	0.790	249.017	71.34810	2.49017	0.69222	-0.36785	0.220897
5	0.750	231.3453	69.82000	2.313453	0.642955	-0.44168	0.294529
6	0.713	214.9989	68.25386	2.149989	0.597385	-0.51519	0.272439
7	0.68	200.4197	66.71324	2.004197	0.556741	-0.58565	0.242987
8	0.64	182.748	64.63281	1.82748	0.507476	-0.67831	0.294529
9	0.623	175.3258	63.67940	1.753258	0.486785	-0.71993	0.123702
10	0.6	165.0762	62.27500	1.650762	0.458211	-0.78042	0.170827
11	0.58	156.2403	60.97414	1.562403	0.433579	-0.83568	0.147265
12	0.564	149.1275	59.85990	1.491275	0.41375	-0.88249	0.118548
13	0.54	138.5686	58.08333	1.385686	0.384314	-0.9563	0.175981
14	0.52	129.7327	56.47115	1.297327	0.359681	-1.02254	0.147265
15	0.503	122.2222	55.00000	1.222222	0.338744	-1.08251	0.125175
16	0.49	116.4789	53.80612	1.164789	0.322733	-1.13093	0.095722
17	0.48	112.061	52.84375	1.12061	0.310416	-1.16984	0.073632
18	0.47	107.643	51.84043	1.07643	0.2981	-1.21033	0.073632
19	0.46	103.2251	50.79348	1.032251	0.285784	-1.25252	0.073632
20	0.45	98.80716	49.70000	0.988072	0.273468	-1.29657	0.073632
21	0.44	94.38922	48.55682	0.943892	0.261152	-1.34265	0.073632
22	0.43	89.97128	47.36047	0.899713	0.248835	-1.39096	0.073632
23	0.42	85.55335	46.10714	0.855533	0.236519	-1.44173	0.073632
24	0.406	79.36824	44.24877	0.793682	0.219276	-1.51742	0.103085
25	0.394	74.15507	42.57991	0.741551	0.204743	-1.586	0.086886
26	0.385	70.22311	41.25357	0.702231	0.193782	-1.64102	0.065533
27	0.375	65.49591	39.57555	0.654959	0.180603	-1.71145	0.078787
28	0.363	60.32693	37.62745	0.603269	0.166193	-1.7946	0.08615
29	0.355	56.83676	36.23944	0.568368	0.156464	-1.85493	0.05817
30	0.35	54.62779	35.32857	0.546278	0.150305	-1.89509	0.036816
31	0.345	52.41882	34.39130	0.524188	0.144147	-1.93692	0.036816
32	0.34	50.20985	33.42647	0.502099	0.137989	-1.98058	0.036816
33	0.335	48.00088	32.43284	0.480009	0.131831	-2.02623	0.036816
34	0.33	45.79192	31.40909	0.457919	0.125673	-2.07407	0.036816
35	0.325	43.58295	30.35385	0.435829	0.119515	-2.12432	0.036816
36	0.32	41.37398	29.26563	0.41374	0.113357	-2.17722	0.036816
37	0.315	39.16501	28.14286	0.39165	0.107199	-2.23307	0.036816
38	0.309	36.51425	26.74757	0.365142	0.099809	-2.3045	0.044179
39	0.3	32.5381	24.55000	0.325381	0.088724	-2.42222	0.066269

40	0.292	29.00376	22.48288	0.290038	0.078871	-2.53994	0.058906
41	0.288	27.23658	21.40625	0.272366	0.073945	-2.60444	0.029453
42	0.277	22.37685	18.2852	0.223769	0.060397	-2.80682	0.080996
43	0.274	21.05147	17.39051	0.210515	0.056702	-2.86995	0.02209
44	0.272	20.16788	16.78309	0.201679	0.054239	-2.91436	0.014726
45	0.27	19.28429	16.16667	0.192843	0.051775	-2.96084	0.014726
46	0.268	18.40071	15.54104	0.184007	0.049312	-3.00958	0.014726
47	0.267	17.95891	15.22472	0.179589	0.048081	-3.03488	0.007363
48	0.266	17.51712	14.90602	0.175171	0.046849	-3.06083	0.007363
49	0.264	16.63353	14.26136	0.166335	0.044386	-3.11484	0.014726
50	0.262	15.74994	13.60687	0.157499	0.041922	-3.17193	0.014726
51	0.26	14.86636	12.94231	0.148664	0.039459	-3.23249	0.014726
52	0.259	14.42456	12.60618	0.144246	0.038228	-3.2642	0.007363
53	0.258	13.98277	12.26744	0.139828	0.036996	-3.29695	0.007363
54	0.257	13.54098	11.92607	0.13541	0.035764	-3.3308	0.007363
55	0.256	13.09918	11.58203	0.130992	0.034533	-3.36585	0.007363
56	0.255	12.65739	11.23529	0.126574	0.033301	-3.40216	0.007363
57	0.254	12.2156	10.88583	0.122156	0.032069	-3.43985	0.007363
58	0.253	11.7738	10.5336	0.117738	0.030838	-3.47901	0.007363
59	0.252	11.33201	10.17857	0.11332	0.029606	-3.51977	0.007363
60	0.251	10.89021	9.820717	0.108902	0.028375	-3.56226	0.007363
61	0.25	10.44842	9.460000	0.104484	0.027143	-3.60664	0.007363
62	0.249	10.00663	9.096386	0.100066	0.025911	-3.65307	0.007363
63	0.248	9.564833	8.729839	0.095648	0.02468	-3.70177	0.007363

(Data sheet 2)

1cm cut	IMC	74.85					
	Dry Matter	25.15					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.22635		
	EMC	0.248					
	60tem.						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	0.9	297.6143	74.85000	2.976143	0.827699	0	
2	0.84	271.1067	73.05357	2.711067	0.753801	-0.28263	0.441794
3	0.783	245.9245	71.09195	2.459245	0.683599	-0.38038	0.419704
4	0.74	226.9273	69.41216	2.269273	0.630639	-0.46102	0.316619
5	0.68	200.4197	66.71324	2.004197	0.556741	-0.58565	0.441794
6	0.64	182.748	64.63281	1.82748	0.507476	-0.67831	0.294529
7	0.605	167.2852	62.58678	1.672852	0.464369	-0.76707	0.257713
8	0.57	151.8224	60.28947	1.518224	0.421263	-0.8645	0.257713
9	0.55	142.9865	58.84545	1.429865	0.39663	-0.92475	0.147265
10	0.53	134.1507	57.29245	1.341507	0.371998	-0.98887	0.147265
11	0.5	120.8968	54.73000	1.208968	0.335049	-1.09348	0.220897
12	0.49	116.4789	53.80612	1.164789	0.322733	-1.13093	0.073632
13	0.472	108.5266	52.04449	1.085266	0.300563	-1.2021	0.132538
14	0.464	104.8156	51.17558	1.048156	0.290218	-1.23712	0.061851
15	0.44	94.38922	48.55682	0.943892	0.261152	-1.34265	0.173772

16	0.43	89.97128	47.36047	0.899713	0.248835	-1.39096	0.073632
17	0.41	81.13541	44.79268	0.811354	0.224203	-1.4952	0.147265
18	0.39	72.29954	41.96154	0.722995	0.19957	-1.61159	0.147265
19	0.38	67.8816	40.43421	0.678816	0.187254	-1.67529	0.073632
20	0.372	64.52397	39.21858	0.64524	0.177894	-1.72657	0.055961
21	0.365	61.25469	37.9863	0.612547	0.16878	-1.77916	0.054488
22	0.358	58.16214	36.77374	0.581621	0.160158	-1.83159	0.051543
23	0.351	55.06958	35.51282	0.550696	0.151537	-1.88693	0.051543
24	0.336	48.44268	32.63393	0.484427	0.133063	-2.01694	0.110448
25	0.331	46.23371	31.61631	0.462337	0.126905	-2.06432	0.036816
26	0.325	43.58295	30.35385	0.435829	0.119515	-2.12432	0.044179
27	0.316	39.6068	28.37025	0.396068	0.10843	-2.22165	0.066269
28	0.310	36.95604	26.98387	0.36956	0.10104	-2.29223	0.044179
29	0.299	32.09631	24.29766	0.320963	0.087493	-2.4362	0.080996
30	0.295	30.32914	23.27119	0.303291	0.082566	-2.49416	0.029453
31	0.289	27.67837	21.67820	0.276784	0.075176	-2.58792	0.044179
32	0.287	26.79479	21.13240	0.267948	0.072713	-2.62123	0.014726
33	0.285	25.9112	20.57895	0.259112	0.07025	-2.6557	0.014726
34	0.284	25.46941	20.29930	0.254694	0.069018	-2.67338	0.007363
35	0.282	24.58582	19.73404	0.245858	0.066555	-2.70973	0.014726
36	0.278	22.68611	18.49118	0.226861	0.061259	-2.79264	0.031662
37	0.273	20.74221	17.17892	0.207422	0.05584	-2.88527	0.032398
38	0.268	18.48907	15.60403	0.184891	0.049559	-3.0046	0.037552
39	0.264	16.63353	14.26136	0.166335	0.044386	-3.11484	0.030926
40	0.261	15.30815	13.27586	0.153082	0.040691	-3.20175	0.02209
41	0.259	14.42456	12.60618	0.144246	0.038228	-3.2642	0.014726
42	0.257	13.54098	11.92607	0.13541	0.035764	-3.3308	0.014726
43	0.256	13.09918	11.58203	0.130992	0.034533	-3.36585	0.007363
44	0.255	12.65739	11.23529	0.126574	0.033301	-3.40216	0.007363
45	0.254	12.2156	10.88583	0.122156	0.032069	-3.43985	0.007363
46	0.253	11.7738	10.53360	0.117738	0.030838	-3.47901	0.007363
47	0.252	11.33201	10.17857	0.11332	0.029606	-3.51977	0.007363
48	0.251	10.89021	9.820717	0.108902	0.028375	-3.56226	0.007363
49	0.25	10.44842	9.460000	0.104484	0.027143	-3.60664	0.007363
50	0.249	10.00663	9.096386	0.100066	0.025911	-3.65307	0.007363
51	0.248	9.564833	8.729839	0.095648	0.02468	-3.70177	0.007363

(Data sheet 3)

1cm cut	IMC	74.85					
	Dry Matter	25.15					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.22635		
	EMC	0.248					

Time(h)	70 Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	0.9	297.6143	74.85000	2.976143	0.827699	0	
2	0.82	262.2708	72.39634	2.622708	0.729169	-0.31585	0.589058
3	0.76	235.7632	70.21711	2.357632	0.655271	-0.42271	0.441794
4	0.700	209.2556	67.66429	2.092556	0.581374	-0.54236	0.441794
5	0.648	186.2823	65.06944	1.862823	0.517329	-0.65908	0.382888
6	0.614	171.2613	63.13518	1.712613	0.475454	-0.74348	0.25035
7	0.571	152.2642	60.35902	1.522642	0.422494	-0.86158	0.316619
8	0.540	138.5686	58.08333	1.385686	0.384314	-0.9563	0.22826
9	0.514	127.082	55.96304	1.27082	0.352292	-1.0433	0.191444
10	0.488	115.5953	53.6168	1.155953	0.320269	-1.13859	0.191444
11	0.467	106.3176	51.53105	1.063176	0.294405	-1.2228	0.154628
12	0.457	101.8997	50.47046	1.018997	0.282089	-1.26553	0.073632
13	0.439	93.94743	48.43964	0.939474	0.25992	-1.34738	0.132538
14	0.425	87.76231	46.74118	0.877623	0.242677	-1.41602	0.103085
15	0.416	83.78617	45.58894	0.837862	0.231593	-1.46278	0.066269
16	0.397	75.39209	42.98489	0.753921	0.208192	-1.5693	0.139901
17	0.389	71.85774	41.81234	0.718577	0.198339	-1.61778	0.058906
18	0.367	62.13828	38.32425	0.621383	0.171243	-1.76467	0.161991
19	0.365	61.25469	37.9863	0.612547	0.16878	-1.77916	0.014726
20	0.352	55.51138	35.69602	0.555114	0.152769	-1.87883	0.095722
21	0.342	51.09344	33.81579	0.510934	0.140452	-1.96289	0.073632

22	0.331	46.23371	31.61631	0.462337	0.126905	-2.06432	0.080996
23	0.315	39.16501	28.14286	0.39165	0.107199	-2.23307	0.117812
24	0.31	36.95604	26.98387	0.36956	0.10104	-2.29223	0.036816
25	0.305	34.74707	25.78689	0.347471	0.094882	-2.35512	0.036816
26	0.295	30.10824	23.14092	0.301082	0.08195	-2.50164	0.077314
27	0.290	28.16435	21.97518	0.281643	0.076531	-2.57006	0.032398
28	0.284	25.46941	20.2993	0.254694	0.069018	-2.67338	0.044916
29	0.278	22.81864	18.57914	0.228186	0.061628	-2.78663	0.044179
30	0.277	22.37685	18.2852	0.223769	0.060397	-2.80682	0.007363
31	0.273	20.60968	17.08791	0.206097	0.05547	-2.89191	0.029453
32	0.269	18.8425	15.85502	0.188425	0.050544	-2.98491	0.029453
33	0.264	16.63353	14.26136	0.166335	0.044386	-3.11484	0.036816
34	0.259	14.42456	12.60618	0.144246	0.038228	-3.2642	0.036816
35	0.257	13.54098	11.92607	0.13541	0.035764	-3.3308	0.014726
36	0.255	12.65739	11.23529	0.126574	0.033301	-3.40216	0.014726
37	0.254	12.2156	10.88583	0.122156	0.032069	-3.43985	0.007363
38	0.253	11.7738	10.5336	0.117738	0.030838	-3.47901	0.007363
39	0.252	11.33201	10.17857	0.11332	0.029606	-3.51977	0.007363
40	0.251	10.89021	9.820717	0.108902	0.028375	-3.56226	0.007363
41	0.25	10.44842	9.460000	0.104484	0.027143	-3.60664	0.007363
42	0.249	10.00663	9.096386	0.100066	0.025911	-3.65307	0.007363
43	0.248	9.564833	8.729839	0.095648	0.02468	-3.70177	0.007363

(Data sheet 1)

2cm cut	IMC	75.98					
	Dry Matter	24.02					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.230592		
	EMC	0.252					
Time(h)	50tem Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	0.96	316.3197	75.98000	3.163197	0.879845	0	0
2	0.927	302.0087	75.12492	3.020087	0.839949	-0.17441	0.238517
3	0.9	290.2998	74.37867	2.902998	0.807307	-0.21405	0.19515
4	0.874	279.0244	73.61648	2.790244	0.775874	-0.25377	0.187922
5	0.845	266.4481	72.71101	2.664481	0.740814	-0.30001	0.209605
6	0.82	255.6064	71.87902	2.556064	0.71059	-0.34166	0.180694
7	0.8	246.9331	71.17600	2.469331	0.68641	-0.37628	0.144555
8	0.78	238.2598	70.43692	2.382598	0.662231	-0.41214	0.144555
9	0.75	225.2498	69.25440	2.252498	0.625962	-0.46847	0.216833
10	0.74	220.9131	68.83892	2.209131	0.613872	-0.48797	0.072278
11	0.73	216.5765	68.41205	2.165765	0.601783	-0.50786	0.072278
12	0.71	207.9031	67.52225	2.079031	0.577603	-0.54887	0.144555
13	0.69	199.2298	66.58087	1.992298	0.553424	-0.59163	0.144555
14	0.68	194.8931	66.08941	1.948931	0.541334	-0.61372	0.072278
15	0.66	186.2198	65.06182	1.862198	0.517155	-0.65941	0.144555
16	0.64	177.5465	63.97000	1.775465	0.492976	-0.7073	0.144555
17	0.62	168.8732	62.80774	1.688732	0.468796	-0.75759	0.144555
18	0.61	164.5365	62.19803	1.645365	0.456707	-0.78371	0.072278
19	0.59	155.8632	60.91661	1.558632	0.432527	-0.83811	0.144555
20	0.58	151.5265	60.24276	1.515265	0.420438	-0.86646	0.072278
21	0.56	142.8532	58.82286	1.428532	0.396258	-0.92569	0.144555
22	0.55	138.5165	58.07418	1.385165	0.384169	-0.95667	0.072278
23	0.53	129.8432	56.49208	1.298432	0.359989	-1.02168	0.144555
24	0.52	125.5065	55.65538	1.255065	0.3479	-1.05584	0.072278
25	0.495	114.6649	53.41576	1.146649	0.317676	-1.14672	0.180694
26	0.485	110.3282	52.45526	1.103282	0.305586	-1.18552	0.072278
27	0.48	108.1599	51.96000	1.081599	0.299541	-1.2055	0.036139
28	0.47	103.8232	50.93787	1.038232	0.287451	-1.2467	0.072278

29	0.465	101.6549	50.41032	1.016549	0.281407	-1.26795	0.036139
30	0.46	99.48654	49.87130	0.994865	0.275362	-1.28967	0.036139
31	0.455	97.31821	49.32044	0.973182	0.269317	-1.31187	0.036139
32	0.45	95.14988	48.75733	0.951499	0.263272	-1.33457	0.036139
33	0.445	92.98154	48.18157	0.929815	0.257227	-1.3578	0.036139
34	0.44	90.81321	47.59273	0.908132	0.251182	-1.38158	0.036139
35	0.435	88.64488	46.99034	0.886449	0.245138	-1.40594	0.036139
36	0.43	86.47655	46.37395	0.864765	0.239093	-1.4309	0.036139
37	0.425	84.30822	45.74306	0.843082	0.233048	-1.45651	0.036139
38	0.415	79.97155	44.43566	0.799716	0.220958	-1.50978	0.072278
39	0.405	75.63489	43.06370	0.756349	0.208869	-1.56605	0.072278
40	0.4	73.46656	42.35200	0.734666	0.202824	-1.59542	0.036139
41	0.385	66.96156	40.10597	0.669616	0.184689	-1.68908	0.108417
42	0.38	64.79323	39.31789	0.647932	0.178644	-1.72236	0.036139
43	0.375	62.6249	38.50880	0.626249	0.1726	-1.75678	0.036139
44	0.37	60.45656	37.67784	0.604566	0.166555	-1.79243	0.036139
45	0.365	58.28823	36.82411	0.582882	0.16051	-1.8294	0.036139
46	0.36	56.1199	35.94667	0.561199	0.154465	-1.86779	0.036139
47	0.355	53.95157	35.04451	0.539516	0.14842	-1.90771	0.036139
48	0.35	51.78324	34.11657	0.517832	0.142375	-1.94929	0.036139
49	0.345	49.6149	33.16174	0.496149	0.136331	-1.99267	0.036139
50	0.341	47.88024	32.37771	0.478802	0.131495	-2.02879	0.028911
51	0.338	46.57924	31.77751	0.465792	0.127868	-2.05676	0.021683
52	0.334	44.84457	30.96048	0.448446	0.123032	-2.09531	0.028911
53	0.331	43.54357	30.33474	0.435436	0.119405	-2.12523	0.021683
54	0.325	40.94158	29.04862	0.409416	0.112151	-2.18791	0.043367
55	0.32	38.77324	27.94000	0.387732	0.106106	-2.24331	0.036139
56	0.314	36.17125	26.56306	0.361712	0.098853	-2.31413	0.043367
57	0.305	32.26825	24.39607	0.322682	0.087972	-2.43074	0.06505
58	0.303	31.40092	23.89703	0.314009	0.085554	-2.45861	0.014456
59	0.299	29.66625	22.87893	0.296663	0.080718	-2.51679	0.028911
60	0.295	27.93158	21.83322	0.279316	0.075882	-2.57857	0.028911
61	0.292	26.63059	21.03014	0.266306	0.072255	-2.62755	0.021683
62	0.29	25.76325	20.48552	0.257633	0.069837	-2.66159	0.014456
63	0.288	24.89592	19.93333	0.248959	0.067419	-2.69682	0.014456
64	0.286	24.02859	19.37343	0.240286	0.065002	-2.73334	0.014456
65	0.284	23.16125	18.80563	0.231613	0.062584	-2.77125	0.014456

66	0.282	22.25056	18.20078	0.222506	0.060045	-2.81266	0.015178
67	0.278	20.55926	17.05324	0.205593	0.05533	-2.89444	0.028188
68	0.277	20.12559	16.75379	0.201256	0.054121	-2.91654	0.007228
69	0.275	19.25826	16.14836	0.192583	0.051703	-2.96224	0.014456
70	0.273	18.39092	15.53407	0.183909	0.049285	-3.01014	0.014456
71	0.271	17.52359	14.91070	0.175236	0.046867	-3.06044	0.014456
72	0.269	16.65626	14.27807	0.166563	0.044449	-3.11341	0.014456
73	0.267	15.78893	13.63596	0.157889	0.042031	-3.16934	0.014456
74	0.266	15.35526	13.31128	0.153553	0.040822	-3.19853	0.007228
75	0.265	14.92159	12.98415	0.149216	0.039613	-3.22859	0.007228
76	0.264	14.48793	12.65455	0.144879	0.038404	-3.25959	0.007228
77	0.263	14.05426	12.32243	0.140543	0.037195	-3.29157	0.007228
78	0.262	13.62059	11.98779	0.136206	0.035986	-3.32462	0.007228
79	0.261	13.18693	11.65057	0.131869	0.034777	-3.35879	0.007228
80	0.26	12.75326	11.31077	0.127533	0.033568	-3.39417	0.007228
81	0.259	12.31959	10.96834	0.123196	0.032359	-3.43085	0.007228
82	0.258	11.88593	10.62326	0.118859	0.03115	-3.46893	0.007228
83	0.257	11.45226	10.27549	0.114523	0.029941	-3.50851	0.007228
84	0.256	11.0186	9.925000	0.110186	0.028733	-3.54973	0.007228
85	0.255	10.58493	9.571765	0.105849	0.027524	-3.59271	0.007228
86	0.254	10.15126	9.215748	0.101513	0.026315	-3.63763	0.007228
87	0.253	9.717596	8.856917	0.097176	0.025106	-3.68466	0.007228
88	0.252	9.28393	8.495238	0.092839	0.023897	-3.73402	0.007228
89	0.252	9.28393	8.495238	0.092839	0.023897	-3.73402	0

(Data sheet 2)

2cm cut	IMC	75.98					
	Dry Matter	24.02					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.230592		
	EMC	0.252					
	60tem						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	0.96	316.3197	75.9800	3.163197	0.879845	0	0
2	0.9	290.2998	74.37867	2.902998	0.807307	-0.21405	0.433666
3	0.867	275.9888	73.40346	2.759888	0.767411	-0.26473	0.238517
4	0.831	260.3768	72.25126	2.603768	0.723888	-0.32312	0.2602

5	0.805	249.1014	71.35503	2.491014	0.692455	-0.36751	0.187922
6	0.766	232.1885	69.89661	2.321885	0.645306	-0.43803	0.281883
7	0.741	221.3468	68.88097	2.213468	0.615081	-0.486	0.180694
8	0.717	210.9388	67.83933	2.109388	0.586066	-0.53432	0.173467
9	0.688	198.3625	66.48372	1.983625	0.551006	-0.59601	0.209605
10	0.66	186.2198	65.06182	1.862198	0.517155	-0.65941	0.202378
11	0.64	177.5465	63.97000	1.775465	0.492976	-0.7073	0.144555
12	0.631	173.6001	63.45031	1.736001	0.481974	-0.72986	0.065773
13	0.61	164.5365	62.19803	1.645365	0.456707	-0.78371	0.15106
14	0.59	155.8632	60.91661	1.558632	0.432527	-0.83811	0.144555
15	0.568	146.3225	59.40282	1.463225	0.40593	-0.90157	0.159011
16	0.56	142.8532	58.82286	1.428532	0.396258	-0.92569	0.057822
17	0.54	134.1799	57.29778	1.341799	0.372079	-0.98865	0.144555
18	0.52	125.5065	55.65538	1.255065	0.3479	-1.05584	0.144555
19	0.51	121.1699	54.78588	1.211699	0.33581	-1.09121	0.072278
20	0.495	114.6649	53.41576	1.146649	0.317676	-1.14672	0.108417
21	0.49	112.4965	52.94041	1.124965	0.311631	-1.16594	0.036139
22	0.48	108.1599	51.96000	1.081599	0.299541	-1.2055	0.072278
23	0.47	103.8232	50.93787	1.038232	0.287451	-1.2467	0.072278
24	0.46	99.48654	49.87130	0.994865	0.275362	-1.28967	0.072278
25	0.45	95.14988	48.75733	0.951499	0.263272	-1.33457	0.072278
26	0.44	90.81321	47.59273	0.908132	0.251182	-1.38158	0.072278
27	0.43	86.47655	46.37395	0.864765	0.239093	-1.4309	0.072278
28	0.42	82.13988	45.09714	0.821399	0.227003	-1.48279	0.072278
29	0.41	77.80322	43.75805	0.778032	0.214913	-1.53752	0.072278
30	0.4	73.46656	42.35200	0.734666	0.202824	-1.59542	0.072278
31	0.39	69.12989	40.87385	0.691299	0.190734	-1.65688	0.072278
32	0.385	66.96156	40.10597	0.669616	0.184689	-1.68908	0.036139
33	0.38	64.79323	39.31789	0.647932	0.178644	-1.72236	0.036139
34	0.375	62.6249	38.50880	0.626249	0.1726	-1.75678	0.036139
35	0.37	60.45656	37.67784	0.604566	0.166555	-1.79243	0.036139
36	0.365	58.28823	36.82411	0.582882	0.16051	-1.8294	0.036139
37	0.36	56.1199	35.94667	0.561199	0.154465	-1.86779	0.036139
38	0.355	53.95157	35.04451	0.539516	0.14842	-1.90771	0.036139
39	0.35	51.78324	34.11657	0.517832	0.142375	-1.94929	0.036139
40	0.345	49.6149	33.16174	0.496149	0.136331	-1.99267	0.036139
41	0.341	47.88024	32.37771	0.478802	0.131495	-2.02879	0.028911
42	0.338	46.57924	31.77751	0.465792	0.127868	-2.05676	0.021683
43	0.334	44.84457	30.96048	0.448446	0.123032	-2.09531	0.028911
44	0.331	43.54357	30.33474	0.435436	0.119405	-2.12523	0.021683
45	0.329	42.67624	29.91125	0.426762	0.116987	-2.14569	0.014456
46	0.326	41.37524	29.26626	0.413752	0.11336	-2.17718	0.021683
47	0.323	40.07424	28.60929	0.400742	0.109733	-2.2097	0.021683
48	0.32	38.77324	27.94000	0.387732	0.106106	-2.24331	0.021683
49	0.317	37.47225	27.25804	0.374722	0.102479	-2.27809	0.021683
50	0.314	36.17125	26.56306	0.361712	0.098853	-2.31413	0.021683

51	0.309	34.00291	25.37476	0.340029	0.092808	-2.37722	0.036139
52	0.305	32.26825	24.39607	0.322682	0.087972	-2.43074	0.028911
53	0.301	30.53358	23.39136	0.305336	0.083136	-2.48728	0.028911
54	0.297	28.79892	22.35960	0.287989	0.0783	-2.54721	0.028911
55	0.293	27.06425	21.29966	0.270643	0.073464	-2.61096	0.028911
56	0.287	24.46225	19.65436	0.244623	0.06621	-2.71492	0.043367
57	0.285	23.59492	19.09053	0.235949	0.063793	-2.75212	0.014456
58	0.282	22.29392	18.22979	0.222939	0.060166	-2.81065	0.021683
59	0.275	19.25826	16.14836	0.192583	0.051703	-2.96224	0.050594
60	0.269	16.65626	14.27807	0.166563	0.044449	-3.11341	0.043367
61	0.266	15.35526	13.31128	0.153553	0.040822	-3.19853	0.021683
62	0.264	14.48793	12.65455	0.144879	0.038404	-3.25959	0.014456
63	0.261	13.18693	11.65057	0.131869	0.034777	-3.35879	0.021683
64	0.26	12.75326	11.31077	0.127533	0.033568	-3.39417	0.007228
65	0.259	12.31959	10.96834	0.123196	0.032359	-3.43085	0.007228
66	0.258	11.88593	10.62326	0.118859	0.03115	-3.46893	0.007228
67	0.257	11.45226	10.27549	0.114523	0.029941	-3.50851	0.007228
68	0.256	11.0186	9.925000	0.110186	0.028733	-3.54973	0.007228
69	0.255	10.58493	9.571765	0.105849	0.027524	-3.59271	0.007228
70	0.254	10.15126	9.215748	0.101513	0.026315	-3.63763	0.007228
71	0.253	9.717596	8.856917	0.097176	0.025106	-3.68466	0.007228
72	0.252	9.28393	8.495238	0.092839	0.023897	-3.73402	0.007228

(Data sheet 3)

2cm cut	IMC	75.98					
	Dry Matter	24.02					
	Wt. of DM	Initial Mass of Sample × (DM%/100)			0.230592		
	EMC	0.252					
	70tem						
Time(h)	Wt sample	MC (db)%	MC (wb)%	g w / g dm	MR	ln MR	dM/Dt
1	0.96	316.3197	75.98000	3.163197	0.879845	0	0
2	0.88	281.6264	73.79636	2.816264	0.783128	-0.24446	0.578222
3	0.84	264.2798	72.54857	2.642798	0.734769	-0.3082	0.289111
4	0.800	246.9331	71.17600	2.469331	0.68641	-0.37628	0.289111
5	0.764	231.3211	69.81780	2.313211	0.642888	-0.44179	0.2602
6	0.712	208.7271	67.60893	2.087271	0.5799	-0.5449	0.376567
7	0.688	198.189	66.46422	1.98189	0.550523	-0.59689	0.175635
8	0.662	187.2606	65.18841	1.872606	0.520057	-0.65382	0.18214
9	0.636	175.8986	63.75479	1.758986	0.488382	-0.71666	0.189368
10	0.614	166.0543	62.41369	1.660543	0.460938	-0.77449	0.16407
11	0.598	159.1157	61.40720	1.591157	0.441595	-0.81736	0.115644
12	0.578	150.5724	60.09138	1.505724	0.417778	-0.87281	0.142387
13	0.567	145.8021	59.31687	1.458021	0.404479	-0.90515	0.079506

14	0.548	137.6925	57.92885	1.376925	0.381872	-0.96267	0.135159
15	0.524	127.0677	55.96028	1.270677	0.352252	-1.04341	0.17708
16	0.500	116.7465	53.86315	1.167465	0.323479	-1.12862	0.172021
17	0.484	109.8078	52.33733	1.098078	0.304135	-1.19028	0.115644
18	0.479	107.5961	51.82954	1.075961	0.297969	-1.21076	0.036862
19	0.466	101.9151	50.47423	1.019151	0.282132	-1.26538	0.094684
20	0.450	95.14988	48.75733	0.951499	0.263272	-1.33457	0.112753
21	0.436	89.07855	47.11193	0.890785	0.246347	-1.40102	0.101189
22	0.427	85.17555	45.99719	0.851755	0.235466	-1.44619	0.06505
23	0.422	83.00722	45.35735	0.830072	0.229421	-1.4722	0.036139
24	0.415	79.97155	44.43566	0.799716	0.220958	-1.50978	0.050594
25	0.408	76.93589	43.48235	0.769359	0.212495	-1.54883	0.050594
26	0.398	72.59922	42.06231	0.725992	0.200406	-1.60741	0.072278
27	0.388	68.26256	40.56907	0.682626	0.188316	-1.66963	0.072278
28	0.38	64.79323	39.31789	0.647932	0.178644	-1.72236	0.057822
29	0.375	62.6249	38.50880	0.626249	0.1726	-1.75678	0.036139
30	0.368	59.58923	37.33913	0.595892	0.164137	-1.80706	0.050594
31	0.363	57.4209	36.47603	0.574209	0.158092	-1.84458	0.036139
32	0.357	54.8189	35.40840	0.548189	0.150838	-1.89155	0.043367
33	0.353	53.08424	34.67649	0.530842	0.146002	-1.92413	0.028911
34	0.349	51.34957	33.92779	0.513496	0.141166	-1.95782	0.028911
35	0.344	49.18124	32.96744	0.491812	0.135122	-2.00158	0.036139
36	0.335	45.27824	31.16657	0.452782	0.124241	-2.08553	0.06505
37	0.325	40.94158	29.04862	0.409416	0.112151	-2.18791	0.072278
38	0.319	38.33958	27.71411	0.383396	0.104897	-2.25477	0.043367
39	0.314	36.17125	26.56306	0.361712	0.098853	-2.31413	0.036139
40	0.309	34.00291	25.37476	0.340029	0.092808	-2.37722	0.036139
41	0.303	31.40092	23.89703	0.314009	0.085554	-2.45861	0.043367
42	0.298	29.23258	22.62013	0.292326	0.079509	-2.53188	0.036139
43	0.292	26.63059	21.03014	0.266306	0.072255	-2.62755	0.043367
44	0.285	23.59492	19.09053	0.235949	0.063793	-2.75212	0.050594
45	0.278	20.55926	17.05324	0.205593	0.05533	-2.89444	0.050594
46	0.275	19.25826	16.14836	0.192583	0.051703	-2.96224	0.021683
47	0.27	17.08993	14.59556	0.170899	0.045658	-3.08658	0.036139
48	0.266	15.35526	13.31128	0.153553	0.040822	-3.19853	0.028911
49	0.265	14.92159	12.98415	0.149216	0.039613	-3.22859	0.007228
50	0.264	14.48793	12.65455	0.144879	0.038404	-3.25959	0.007228
51	0.262	13.62059	11.98779	0.136206	0.035986	-3.32462	0.014456
52	0.26	12.75326	11.31077	0.127533	0.033568	-3.39417	0.014456
53	0.259	12.31959	10.96834	0.123196	0.032359	-3.43085	0.007228
54	0.258	11.88593	10.62326	0.118859	0.03115	-3.46893	0.007228
55	0.257	11.45226	10.27549	0.114523	0.029941	-3.50851	0.007228
56	0.256	11.0186	9.925	0.110186	0.028733	-3.54973	0.007228
57	0.255	10.58493	9.571765	0.105849	0.027524	-3.59271	0.007228
58	0.254	10.15126	9.215748	0.101513	0.026315	-3.63763	0.007228
59	0.253	9.717596	8.856917	0.097176	0.025106	-3.68466	0.007228
60	0.252	9.28393	8.495238	0.092839	0.023897	-3.73402	0.007228

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