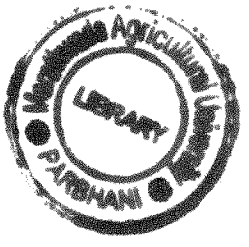
ANTI-DIABETIC FUNCTIONAL FOOD PRODUCT DEVELOPMENT USING JAMUN (*Syzygium cuminii*) AND JAMUN WASTE (SEED).

By

VINOD BHANUDAS RANVEER
B. Tech. (Food Technology)



DISSERTATION

Submitted to the
Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani In
Partial fulfillment of the requirements
For the degree of

MASTER OF TECHNOLOGY

IN

FOOD TECHNOLOGY

COLLEGE OF FOOD TECHNOLOGY
VASANTRAO NAIK MARATHWADA KRISHI VIDYAPEETH
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Affectionately Dedicated
to my Beloved Parents,
Brother, Sister,
Teachers and Friends who guided
Me to be what I am today...

CANDIDATE'S DECLARATION

I hereby declare that the dissertation or part thereof has not been previously submitted by me for a degree of any University or Institute

Place : PARBHANI
Date : 21/06/2013

(VINOD RANVEER)
(Reg. No. 2011T11M)

Dr. A. R. Sawate
Associate Professor and Head,
Department of Food Engineering,
College of Food Technology,
V. N. M. K.V., Parbhani -431 402 (M.S.), India.

CERTIFICATE-I

This is to certify that **Mr. VINOD BHANUDAS RANVEER** has satisfactorily prosecuted his course credit and research work for a period not less than four semesters and that the dissertation entitled **"ANTI-DIABETIC FUNCTIONAL FOOD PRODUCT DEVELOPMENT USING JAMUN (*Syzygium cuminii)* AND JAMUN WASTE (SEED)"** submitted by him is the result of original research work and is of sufficiently high standard to warrant it's presentation to the examination. I also certify that the dissertation or part thereof has not been previously submitted by him for the award of a degree of any university.

Place: PARBHANI
Date : 21 / 06 /2013

Dr. A. R. Sawate
(Research Guide)

CERTIFICATE-II

This is to certify that the dissertation entitled **"ANTI-DIABETIC FUNCTIONAL FOOD PRODUCT DEVELOPMENT USING JAMUN (*Syzygium cuminii)* AND JAMUN WASTE (SEED)"** submitted by **Mr. VINOD BHANUDAS RANVEER** to the Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani in partial fulfillment of the requirements for the degree of **MASTER OF TECHNOLOGY (FOOD TECHNOLOGY)** has been approved by the students advisory committee after Viva-voce examination in collaboration with the external examiner.

Dr. Syed. H.M.

External Examiner

Dr. A. R. Sawate
(Research Guide and chairman)

Members of Advisory Committee

Dr. A. B. Rodge
Associate Professor and Head,
Department of Food Chemistry and Nutrition
College of Food Technology,
V.N.M.K.V., Parbhani

Dr. D. M. Shere
Associate Professor,
Dept. of Food Science and Tech.
College of Food Technology,
V.N.M.K.V., Parbhani

Prof. R. B. Kshirsagar
Associate Professor
Dept. of Food Engineering
College of Food Technology
V.N.M.K.V., Parbhani

Prof. B. M. Patil
Assistant Professor
Dept. of Food Engineering
College of Food Technology
V.N.M.K.V., Parbhani

Associate Dean and Principal
College of Food Technology,
V.N.M.K.V., Parbhani-431402.

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VRanveer

Date: - 21.06.2013 *(Vinod Ranveer)*

Place : Parbhani ***(Reg. No. 201tT11M)***

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LIST OF ABBREVIATIONS

%	:	Per cent
°Bx	:	Degree brix
CD	:	Critical Difference
Cp	:	Centi-poise
et al.	:	*et alibi* (and associates)
etc	:	Etcetera
g	:	Gram
h	:	Hour/s
i.e.	:	id est (That is)
Kg	:	Kilogram
mg	:	Milligram
min	:	Minute
No.	:	Number
NTU	:	Nephrometric turbidity unit
°C	:	Degree Celsius
SE	:	Standard Error
Viz	:	*Videelict* (namely)

INTRODUCTION

Chapter I

INTRODUCTION

The history of plant based health care goes back to antiquity and as old as human civilization. Plants have been primary source of medicines in the tradition healthcare system around the globe, till recently and even currently in most of the developing countries. The approach to characteristics and isolation of active ingredients from plants started in the late 19th century. Consequently chemical substances isolated are currently used as important drugs as such or as their derivatives today. From 1983 to 1994, 39% of the New Approved Drugs (NAD) were of natural origin, original natural products and synthetic products based on natural molecules (Crag *et al.*, 1997). Parallel to synthetic product drug demand, the global natural product market is growing exponentially. The global demand for botanical and plant derived drugs is expected to increase from 19.5 billion USD in 2008 to 32.9 billion USD in 2013, with a compound annual growth rate of 11.0%. (Lawson, 2009)

The number of higher plant species is estimated at 250,000 of these, only around 6% have been screened for biological activity, and of which only 15% are reported to be phytochemically characteristics (Verpoorte, 2000). Asia, especially the southern region shares about 20% of the all known vascular plants in the globe. This includes 7000-8000 species of medicinal plants. According to world health organization (WHO), 65-80% of the global population use plants and plants product for their primary health care (Bagozzi, 2003; Farnsworth *et al.*, 1985). The investigation on therapeutic application of plants have led to the discovery of several clinically applicable drugs (e.g. digoxin, digitoxin, morphine, reserpine, taxol, vinblastine, vincristine etc.) Elucidation of the structure of active principles paved the way for synthesis and derivatization for compounds with higher efficacy

and adverse effects (e.g. Metformin, nabilone, oxycodon, taxptere, teniposide, verapamile, amiodarone etc) Thus plants continue to engage the attention of scientists associated with drug discovery.

Evidences accumulated thus show that plants are rich source of bio-active chemical entities. Many phytochemicals are capable of modulating biochemical pathways of higher animals. However phytochemicals can be beneficial or harmful. There is sufficient traditional knowledge to substantiate this but further studies are required to index plants with beneficial and adverse effects. Based on the traditional knowledge, some plant and plant products are documented to be non-toxic and therapeutically potent. This knowledge can be exploited to develop cheaper plant based product formulation for preventive health and disease management. However scientific evidences need to be created for their efficacy through pharmacological and chemical studies. Greater number of plants documented in the Indian traditional medicine yet to be investigated in this line.

Allopathic drugs used for the treatment of diabetes have their own side effect & adverse effect like hypoglycemia, nausea, vomiting, flatulence, diarrhea, constipation, alcohol flush, headache, weight gain, lactic acidosis, pernicious anemia, dyspepsia, dizziness, joint pain. So instead of allopathic drugs, herbal drugs are a great choice which is having more or less no side effect & adverse effects (Kokar and Mantha, 1998). Ethno-botanical information identified about 800 Indian plants which may have anti-diabetic potential (Gupta, 1986) All the herbs formulation were procured from local, authentic herbs supplier shops, specialized in sale of medicinal plants & run by the Ayurvedic specialist as OTC Ayurvedic medicines. Though complementary & alternative medicine (CAM) treatments are popular, scientific evidence support their application to diabetes care is scare (Tripathi K.D, 2007). Previous CAM diabetes research has generally focused on single modalities but CAM practitioners more commonly prescribed

complex, multi-dietary intervention. Ayurvedic interventions may benefit patients with higher base line HbA1c value, warranting further research (Yadav *et al*, 2002).

India is the "Diabetes capital of the world" (IDF, Diabetes Atlas, 2006). World Health Organisation (WHO) report shows that 32 million people Indians had diabetesin the year 2002. International Diabetes Federation (IDF) estimates the total number of diabetic subjects to be around 40.9 million in India and this is further set to rise to 69.9 million by the year 2025 (Sicree *et al*, 2006). In India diabetes prevalence is highest in South India (Mohan V, 2007 and Gupta *et al*, 2003) with Kerala having the highest share at 19.5%. (Menon *et al*., 2006). Diabetes prevalence is more in developing countries and it is increasing with increased income and decrease in physical exercise (IDF, Diabetes Atlas, 2009). Now it has changed its definition from epidemic to pandemic disease. There are number of food commodities in nature that help to cure and prevent Type 2 diabetes.

There are several types of jamun found in India that differ in color and size of the fruit. The improved races bearing purple to violet or white colored flesh and seedless fruit have been developed. Two types are commonly observed in India, the raw Jamun bearing big oblong, deep purple or bluish fruits with pink greyish, juicy, sweet pulp, small stone and the second inferior, sour (khatta) bearing small fruits with acidic pulp (Anon, 1988).

Jamun seeds have high moisture content and therefore remain sensitive to desiccation. The limited storage potential of recalcitrant seeds is a big problem in the maintenance of seed banks for long term conservation. Sub-zero, and in some cases higher than zero temperature significantly damage the recalcitrant seeds, therefore temperature cannot be reduced greatly. This situation may limit the scope

of modification in seed storage environment and even difficult to improve the storage life of recalcitrant seeds (King and Roberts, 1980; Roberts *et al.,* 1984)

Jamun of good size and quality, having a sweet or sub-acid flavour and a minimum of astringency, are enjoyable raw and may be made into valuable products like sauces and jam (Kennard and Winters1960). Good quality jamun juice is excellent for sherbet, syrup and squash (Miller *et al,* 1955).The ripen jamun fruit is particularly welcomed by the people of low income groups because of its low price. The fruit is generally consumed in fresh condition with or without salt. A wine is prepared from ripe fruit in Goa and liquor is also distilled from it. The unripe fruit juice is stomachic, carminative and diuretic in nature and has cooling and digestive properties (Kirtikar and Basu, 1975). The juice of unripe fruit is used for preparing vinegar. The bark is astringent and used in the preparation of mouth washes. A decoction of bark is useful in diarrhoea and dysentery. The various essential oils (0.18%) are extracted from the dried jamun leaves. The seeds contain about 19% tannins (Anon., 1976). The powdered seeds are useful in diarrhoea, dysentery, diabetes and for reducing the sugars in urine quickly. It is used as lotion for the cure of ringworm (Dastur, 1952).

The ripe jamun fruits are used for making preserves, squashes, jam and jellies (Anon., 1988). The most of the ripe fruits available today are not utilized due to lack of processing techniques. Small quantities of ripe fruits are used as table purpose and lot of the fruits go waste during season due to their highly perishable nature. It is therefore necessary to find out ways and means of processing the fruits for various products preferably near the site of production. This will help in reducing the losses during transportation, storage and also help in rural employment. The mature fruits are living entities even after harvest and contain high amount of moisture. They dry up or deteriorate faster during post-

harvest handling and storage. The storage life of jamun fruits is 24 h at room temperature. Jamun seeds are very useful in diabetic patients (Ramanjanaya, 1985). The world is facing an explosive increase in the incidence of diabetes mellitus. A balance between glucose production and its utilization is necessary to maintain normal blood glucose level. The medicinal value of jamun lies in its leaves, fruits, seed and bark. The seeds of jamun are widely considered to have anti-diabetic properties (Sharma *et al.,* 2008).

Jami showed wide range of phytochemicals like Jambosine, Gallic acid, ellagic acid, corilagin 3,6- hexahydroxydiphenylglucose,1-galloylglucose,3-galloylglucose, quercetin, β-sitosterol, 4,6- hexahydroxydiphenylglucose, Jamun seeds contain alkaloids namely jambosine, glycoside and antimellin. These alkaloids stop the conversion of starch into sugar. The seeds also contain a phenolic substance called ellagic acid, traces of pale yellow essential oil, chlorophyll, fat, resin, egallic acid and albumen. (Sagrawat *et al.*, 2006).

The seed extract of jamun seed contains high amount of polyphenolic components which may be responsible for its potential antioxidant activity. Free radicals are important contributors to various degenerative diseases such as cancer. The observed antioxidant properties of the seed extract of jamun seed might be useful for the development of newer and more potent and natural antioxidant thus can be used as potential free radical scavengers and its various damages. The high growth inhibitory and cytotoxic effect of jamun seed extract against cervical cancer cells show that it can be used as potential anti-carcinogenic agents. The in vitro bio assays provide an introspective knowledge of antibacterial, free radical scavenging and anti-cancerous activities of jamun seed. (Parmar *et al.*, 2010). Ravi (2004) has shown that jamun seed gives benefits of chromium, magnesium, and antioxidant

supplements in type 2 diabetes and hypoglycaemic effect by inorganic constituents in jamun seed on streptozotocin-induced diabetes in rats.

In India, jamun seed are easily available in markets. Despite the availability of many anti-diabetic medicines in the market, diabetes and its related complication continue to be major medical problem. Plant derivatives with purported hypoglycaemic properties are used in folk medicine and traditional healing systems around the world. Because of their effectiveness, minimal side effects and relatively low cost, herbal drug are prescribed widely even when their biologically active ingredients are unknown (Valiathan, 1998). Substantial efforts have been made in recent years to identify new natural and synthetic antidiabetic components.

Studies conducted on type 2 diabetic human volunteers showed that administration of whole *Syzygium cumini* fruit extract decreased serum glucose level significantly in a dose dependent manner (Safdar *et al.*, 2006). Several studies reported the anti-diabetic potential of the anatomical parts of fruit. Water and alcohol extracts of edible portion of fruit (pulp) were reported to have anti-hyperglycemic activity (Pepato *et al.*, 2005). There is more number of reports on the anti-hyperglycemic properties of seed than that of pulp. *S. cumini* seed's aqueous extract has been studied for the capacity to ameliorate glucose metabolizing enzymes in alloxin induced dibetic rats. (Prince and Menon., 1997).
In another advanced study, diabetic and normal rats were fed with the diet containing 15% seed powder, 15% defatted seed powder and 6% water soluble gummy fiber isolated from seed (Pandey and Khan, 2002). The Treatment with 6% water soluble gummy fiber significantly lowered blood glucose level and showed improved oral glucose tolerance test. Whereas feeding diet containing 15% powdered degummed seeds, 2.25% water insoluble neutral detergent fiber neither lower blood glucose level nor improved oral glucose tolerance test. Based on this

data, author suggested that in vivo hyperglycemic effect might be due to the fraction containing gummy fiber. *S. cumini* bark was reported to have anti-diabetic activity substantiated with positive oral glucose tolerance test in mouse model (Villasen and Lamadrid, 2006) and STZ induced diabetic rat model (Saravanan and Pari, 2008). Leaves were also reported to have anti-diabetic activity (Ravi *et al.*, 2004). It is generally observed that anti-diabetic activity of *S. cumini* is mainly found in seed alcohol extract (Prince *et al.*, 2005). Flavonoid rich extracts prepared from *S. cumini* seed alcohol extract was found to have comparatively better hypoglycemic activity than that of the kernel crude methanol extract (Sharma *et al*,. 2008). Administration of lyophilised *S. cumini* plant powder has been reported to have anti-hyperglycemic effect in STZ induced diabetic rat (Grover *et al.*, 2000). Apart from anti-hyperglycaemic effect, the whole plant is known to reduce renal hypertrophy and urinary albumin level in STZ induced diabetic rat model. (Grover *et al.*, 2001). It has been reported that feeding rats with 400mg plant extract /day for 15 days prevented hyperglycaemia and hyper insulinemia induced by high fructose diet (Vikrant *et al.*, 2001). Hypoglycaemia effect of plant extract has also been shown in Streptozyn induced diabetic rat (Grover *et al.*, 2002). Advanced molecular studies showed that methanol extract of *S. cumini* plant modulate the expression of glucose transporter (Glut-4), peroxidase proliferator activator receptor gamma and phosphatidylinositol-3-kinase (PI3) comparable with insulin and rosiglitazone (Anandharajan *et al.*, 2006). Inorganic contents such as Zn, Cr, V, K and Na in *S. cumini* seed has been reported to exhibit normoglycemia and better glucose tolerance in STZ induced diabetic rats (Ravi *et al.*, 2004).

The plants and their parts are the primary medicines in the traditional healthcare system around the globe. Several researches reported the importance of the jamun and jamun seed as an antidiabetic, astrigent, carminative, stomachic and diuretic agent.

In view of the above importance of jamun and jamun seed as a medicinal value with special reference to its antidiabetic property. Since efforts have been made in this area of investigation to development and evaluate the quality attributes of anti-diabetic functional food product viz. Juice by using jamun and jamun seed extract with following objectives:

Objectives:

1. To investigate the physico-chemical properties of jamun fruit
2. To standardize the process of preparation of the jamun seed extract
3. To study the preparation of the jamun fruit juice with jamun seed Extract
4. To assess the physico-chemical and organoleptic quality of prepared juice
5. To calculate the theoretical energy value of product
6. To study techno-economic feasibility of product

REVIEW OF LITERATURE

Chapter II

REVIEW OF LITERATURE

Diabetes is the world's largest endocrine disease, involving metabolic disorders of carbohydrate and fat. Therefore, it is necessary to look for new drugs and interventions that can be used to manage this metabolic disorder. Although many drugs are available to manage diabetes, in most instances these are expensive for the developing countries and they may also have adverse effects, e.g. hypoglycaemia, obesity. On the other hand, India is a country with a vast reserve natural resources and rich history of traditional medicine (Grover *et al.*, 2002). More than 400 plants with glucose-lowering effects are known. Among these plants, some have been reported to possess hypoglycaemic effects (Babuand Prabuseenivasan., 2007; Wang and Ng, 1999) and some hypolipidemic effects (Sharma *et al.*, 2004).

Many common foods are fried, making them high in fats whereas natural fruit juices like jamun juice can easily incorporate functional compound to the product. For this reason, the juice with additional hypoglycaemic compounds like minerals, fibers and phytochemicals would not only be more nutrient dense but also lower the adverse effect of such fatty food.

The literature pertaining to different aspects of the present study entitled has been reviewed under the following captions.

2.1. Physico-chemical characteristics of jamun fruit

2.2. Health promoting effects of jamun fruit

2.3. Preparation of the anti-diabetic product

2.1. Physico-Chemical properties of Jamun fruit

Khurdiya and Roy (1985) reported that the moisture content of ripe jamun juice varied from 80.4 to 81.2 per cent. The total soluble solids content of fresh juice varied from 12.60 to 13.20°Brix, while acidity ranged between 1.24 to 1.32 per cent. The juice contained 8.40 to 9.06 per cent total sugars with reducing sugar ranging from 7.41 to 8.06 per cent. Jamun juice contained anthocyanin (pigment) in the range of 210 to 243mg/100g, which imparts typical deep purple colour to the fruits. Jamun fruits taste astrigent due to more amounts of tannins that ranged between 386.25 to 428.26 mg/100g.

Garande (1992) reported that physical characteristics of fruits play a very important role in development of a processing technology and on quality of final products. At full ripening, jamun had an average length of 3 cm and average weight of 7.8 g/fruit. The fruit consist of about 75.67 per cent edible portion as pulp. The average weight of seed was 1.92 g and pulp to seed ratio 3.11:1.

Noomirio and Umar (1996) measured the minerals, vitamins, free sugars and amino acids of *Eugenia jambosa* fruit. Sufficient amount of sodium (391.5 mg), potassium (278.4 mg), calcium (116 mg), iron (0.58 mg), zinc (0.29 mg) and manganese (0.58 mg) per kilogram were found to be present in *Eugenia jambosa* fruit. The chromatographic analysis showed that fruit contains glucose, mannose, sucrose, alanine, arginine, asparagine, tyrosine, glutamine and cysteine.

Benherlal and Arumughan (2007) reported that Jamun (or Indian blackberry) contains 19.7% carbohydrates, 0.7% proteins, 0.02% calcium, 0.1% fat, 0.01% phosphorous, 0.1% iron, 0.4% mineral matter and 0.9% fiber.

Chowdhury and Ray (2007) prepared red wine from anthocyanin-rich tropical jamun fruit having medicinal (anti-diabetic and curing bleeding piles)

properties by fermentation using wine yeast *(Saccharomyces cerevisiae)* and quality attributes compared with commercial grape red wines. The wine was sparkling red in colour, acidic in taste, high tannin and low alcohol (6%) concentration. Though sensory evaluation rated the jamun wine quite acceptable as an alcoholic beverage, significant differences ($P< 0.05$) exist between jamun wine and commercial grape wine particularly in taste, flavour and after taste probably due to high tannin content in the jamun wine.

Muhammad *et al.,* (2009) studied the nutritive values of stored jamun products, viz., jam, squash, ready-to-drink juice, seed powder and pulp powder. Beside jam, squash and juice products, jamun seed and pulp powder also have good nutritive values and were quite rich in carbohydrates accompanied by enough protein, ash, crude fibres but were not sufficient in fat composition. It was observed that nutritional values varied at different packaging and storage temperature. The glass package among the packages and refrigerator temperature among the storage temperatures showed good results in terms of retaining good quality nutritive values and extended shelf life of the products.

Muhammadand Saghir., (2011) studied the morphological parameters includes weight, volume, length, diameter, shape, colour, firmness/softness, edible and non-edible contents, specific gravity, juice and seed contents. Two prominent cultivars of jamun, that is, (V1) improved and (V2) indigenous varieties were analysed. The improved cultivar was found superior in all parameters analysed whereas indigenous cultivar was found substandard except seed portion which was more in it. The weight, length, width and volume of V1 was determined as 9.55 g, 3.88 cm, 2.98 cm and 7.60 ml whereas V2 was determined as 6.71 g, 2.73 cm, 2.10 cm, and 5.33 ml respectively. Likewise, edible portion was 69.10% whereas non-edible portion was 30.90% in V1. In case of V2, edible portion was determined as 39.19% whereas non-edible portion was 60.81%. These few parameters indicate

that V1 is comparatively better than V2. These research findings would be beneficial references for processors, post-harvest practitioners and fruit exporters.

Chaudhary and Mukhopadhyay, (2012) investigated *Syzygium cumini*(L.) skeels: a potential source of nutraceuticals. The tree has a great economic importance since most of the parts like the bark, leaves, seed and fruits are used as an alternative medicine to treat various diseases. It is used in well-known traditional medicines to control the blood sugar level in the patients suffering from diabetes. The tree is rich in phytochemicals like glycoside jambolin, anthocyanins, tannins, terpenoids, gallic acid and various minerals. These wide ranges of health promoting compounds make them a suitable food material to be used as a nutraceutical. The fruits are purplish black in colour when ripe and have high anthocyanin content. It is a seasonal fruit and is consumed fresh for its nutrient value. Fruits are also processed to make jam, jellies, squash, vinegar and ice cream for its good and attractive purple colour. There are many commercial herbal brands in India and other Asian countries which manufacture these products and are very popular among the consumers. Even though there have been a number of successful research on the medicinal properties of *S. cumini* extracts in animal models and in vitro animal cell lines there are no reports on clinical trial experiments to study the in vivo effect of the phytochemicals on human beings.

Muhammad *et al.*, (2012) study was to determine the mineral contents of jamun fruit (*Eugenia jambolana*) products namely jam, squash, ready-to-drink juice, pulp powder and seed powder.

2.2 Health promoting effects of jamun fruit

Bhargava *et al.*, (1968) reported that jamun fruits and seeds are sweet, acidic and sour and they are used for treatment and control of diabetes, diarrhoea and ringworm. It is also reported to be a blood pressure regulator.

Giri *et al.*, (1985) reported that alloxan induced diabetic rats were fed with jamun seed extract, the blood glucose, blood urea, serum cholesterol and serum triglyceride levels were found to decrease significantly.

Mahpara *et al.*, (2006) studied the effect of jamun fruit extract on glucose and lipid in type 2 diabetic individuals of both sexes for 12 days. Whole jamun fruit extract was prepared in distilled water. 90 ml extract was given to the diabetic subjects in 3 doses per day after breakfast, lunch and dinner. Fasting blood samples were collected from the subjects on day 0, during the experiment (days 4 and 8) and 4 days after the stoppage of jamun extract (day 12). Serum glucose, Total Glycerol lipoprotein (TGL), High Density lipoprotein (HDL) and Low Density lipoprotein (LDL) were determined. After consumption of jamun extract, there was decrease in serum glucose in some individuals but not significant. Similar pattern was observed in serum TGL. Total cholesterol was decreased, but non-significantly. Also LDL was non-significantly decreased. HDL was not affected. The serum glucose, total cholesterol and LDL were lower on day 12, when the individuals were not using jamun extract, than the values for these parameters on day 0, when the individuals had not started yet the intake of jamun extract, making a clue that the extract effect may be appearing after some time. The results of this study are not conclusive, may be due to the preservatives used or short experimental period.

Suman *et al.,* (2006) studied the oral anti-hyperglycaemic effect of the water and ethanolic extracts of the fruit-pulp of *Eugenia jambolana* (EJ) was studied in alloxan-induced diabetic rat. Water extract was found to be more effective than the ethanolic extract.in reducing fasting blood glucose. When administered as a single dose of 25 mg/kg of body weight; F-III could reduce fasting blood glucose from 174.0 ±4.6 to 137.3 ±5.4 mg/dl in diabetic (21% falls) and from 266.0 ±5.4 to 202.2 ±5.2 mg/dl in severely diabetic rabbits (24% fall). After treatment of diabetic and severely diabetic rabbits daily once with 25 mg/kg, body weight with F-III for 7 and 15 days, respectively, there was fall in fasting blood glucose (38% diabetic; 48% severely diabetic) and improvement in blood glucose during glucose tolerance test (48%) in diabetic rabbits. Further, there was increase in the plasma insulin levels in both diabetic (24.4%) and severely diabetic rabbits (26.3%). The in vitro studies with pancreatic islets showed that the insulin release was nearly two and half times more than that in untreated diabetic rabbits.

Mastan *et al.,* (2008) investigated immunomodulatory activity of methanolic extract of *Syzygium cumini* seeds The study was conducted to investigate the immunomodulatory activity of methanolic extract of *Syzygium cumini* seeds (SME) in mice and rats at doses of 100, 200, 300, 400 and 500 mg/kg orally. Immunomodulatory activities on humoral and cellular immunity were studied by carbon clearance method in mice and hemagglutination (HA) titre, delayed type hypersensitivity (DTH) reaction in rats. SME enhanced the carbon clearance, HA titre and DTH reaction in a dose dependent manner. SME also significantly increased the white blood cells and lymphocytes count. The effects were compared to the standard druglevamisole. The results suggest that the methanolic extract of *Syzygium cumini* seeds possesses promising immunomodulatory activity.

The antioxidant activity of *Syzygium cumini* leaf extracts was investigated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical-scavenging and ferric-reducing antioxidant power (FRAP) assays. The methanolic extract and its water, ethyl acetate, chloroform, and *n*-hexane fractions were prepared and subjected to antioxidant evaluation. The results showed that the ethyl acetate fraction had stronger antioxidant activity than the other ones. HPLC data indicated that *S. cumini* leaf extracts contained phenolic compounds, such as ferulic acid and catechin, responsible for their antioxidant activity. (Zhi *et al.*, 2008).

Sapana *et al.*, (2009) studied the accurate and precise high-performance thin-layer chromatographic method for quantification of 3-hydroxy androstane. The compound was isolated from the ethanol extract and identification was confirmed by using melting point and IR, NMR spectroscopy. An ethanol extract of the seed powder was chromatographed on silica gel 60F-254 plate with toluene: ethyl acetate (8.5:1.5 v/v) as mobile phase. Detection was performed by scanning in fluorescence mode at 366 nm. The method was validated for linearity, accuracy, recovery, precision, limit of detection, limit of quantification and specificity. The linear regression analysis data for the calibration plots for 3-hydroxy androstane [16, 17-C] (6'methyl, 2'-1-hydroxy –isopropene-1-yl) 4, 5, 6 H-pyran showed good linear relationship with Regression value (R^2) = 0.999, in the concentration range of 1000-5000 μg/spot. The limit of detection and limit of quantification were 131and 430 μg/spot, respectively. The amount of 3-hydroxy androstane [16, 17-C] (6'methyl, 2'-1-hydroxy –isopropene-1-yl) 4, 5, 6 H-pyran found in seed powder extract was 7.38%. This method can be used as quality control method for checking the purity of *Syzygium cumini* seed powder, extract and its formulation.

Goyal *et al.*, (2011) showed that *Syzygium cummini* extract (SCE) was used in the present study to explore anti-tumour promoting activity in a stomach

carcinogenesis model in mice. For this purpose, Swiss albino mice were administered with 1 mg of benzo-a-pyrenein 100µl sesame oil by oral method give twice a week for 4 consecutive weeks.

Kavishankar *et al.,* (2011) mentioned that oral administration of 2.5 and 5.0 g/kg body weight of the aqueous extract of the seed for 6 weeks results in significant reduction in blood glucose and an increase in total haemoglobin, but in the case of 7.5 g/kg body weight the effect was not significant. The aqueous extract also decreases free radical formation which clearly shows the antioxidant property. Thus the study showed that Jamun seed extract has hypoglycaemic action.

Gangadhar *et al.,* (2011) carried out antibacterial study and effect of ethanolic extracts of *Syzygium cumini* seeds powder on glucoamylase *in-vitro.* Antibacterial activity against *E. coli, B. subtilis, P. aeruginosa and S. aureus and* inhibitory effect onglucoamylase of ethanolic extracts isolated at different temperatures from seeds of *Syzygium cumini* was investigated in vitro. All four strains were observed with moderate to good antibacterial activity. The ethanolic extract isolated at 200°C showed maximum inhibition (50%) of glucoamylase activity. Thus they reported the ethanolic extract of *Syzygium cumini* seeds is antibacterial and also potent inhibitor of glucoamylase.

Joyita and Narendhirakannan. (2011) the major phytoconstituents present in *S. cumini* seeds were determined by GCMS analysis which showed the presence of polyphenols, sesquiterpenes, n-alkanes. The antibacterial activity of ethanolic extract of *S. cumini* seeds were tested against common human pathogens by agar well diffusion method and minimum inhibitory concentration required to inhibit the growth of various pathogens were also evaluated. The seed extract was found to have high antibacterial activity. The total polyphenolic content of the ethanolic extract of *S. cumini* seed was determined by Folin-Ciocalteau method. The

antioxidant activity of *S. cumini* seed ethanolic extract was evaluated by DPPH free radical scavenging assay, reducing power assay and total antioxidant capacity.

Suman *et al.*, (2011) evaluate the antidiabetic activity of LH II purified from ethanolic seed extract of *Eugenia jambolana* in alloxan-induced mild diabetic (MD) and severely diabetic (SD) rabbits. Ethanolic extract upon chromatographic purification yielded partially purified hypoglycaemic principle (SIII) which on further purification by sephadex LH 20 yielded pharmacological active compound LH II. Homogeneity of LH II was tested by HPLC. Phytochemical investigation of LH II by various structural spectra showed the presence of saturated fatty acid, ω-5 lipid and presence of sterol.

Prakash *et al.*, (2012) studied the fruits of *Syzygium cumini* known to possess high medicinal value have been evaluated for its antibacterial activity against some gram positive and gram negative bacterial strains. Zone of inhibition were obtained against all bacterial strains tested except for *Micrococcus luteus* against ethyl acetate fractions and *Salmonella paratyphi* using diethyl ether and ethyl acetate fractions. High zone of inhibition was obtained against *Bacillus cereus* using diethyl ether extract. Lowest minimum inhibitory concentration value of 0.25 mg/ml of diethyl ether extract of pre-ripened fruits was effective against *Bacillus cereus*. The activity of the extracts varied along with the fruits maturity, signifying the role of maturity indices in accumulation of bioactive compounds.

2.3. Preparation of Antidiabetic jamun product

Archana *et al.*, (2005). studied the antioxidant activity of the *Syzygium cumini* fruit skin using different assays, such as hydroxyl radical-scavenging assay, based on the benzoic acid hydroxylation method, superoxide radical-scavenging assay, based on photochemical reduction of nitrobluetetrazolium(NBT) in the

presence of a riboflavin-light-NBT system, DPPH radical-scavenging assay, and lipid peroxidation assay, using egg yolk as the lipid-rich source. Total antioxidant capacity was determined by the assay based on the reduction of Mo (VI)–Mo (V) by the extract and subsequent formation of a green phosphate/Mo (V) complex. In all the systems, a significant correlation existed between concentration of the extract and percentage inhibition of free radicals and percentage inhibition of lipid peroxidation. The antioxidant property of the fruit skin may come in part from the antioxidant vitamins, phenolics or tannins and anthocyanins present in the fruit.

Liya *et al.*, (2006) reported that *Eugenia jambolana Lamarck*, berry extract inhibits growth and induces apoptosis of human breast cancer but not non-tumorigenic breast cells. They carried out study with the objectives: to prepare a standardized jamun fruit extract (JFE) for biological studies and, to investigate the anti-proliferative and pro-apoptotic effects of JFE in estrogen dependent/aromatase positive (MCF-7aro), and estrogen independent (MDA-MB-231) breast cancer cells, and in a normal/non-tumorigenic(MCF-10A) breast cell line. JFE was standardized to anthocyanin content using the pH differential method, and individual anthocyanins were identified by high performance liquid chromatography with ultraviolet (HPLC-UV) and tandem mass spectrometry (LC-MS/MS) methods.JFE contained 3.5% anthocyanins (as cyanidin-3-glucoside equivalents) which occur as diglucoside of five anthocyanidins/aglycons: delphinidin, cyanidin, petunidin, peonidin and malvidin. In the proliferation assay, JFE was most effective against MCF-7aro (IC50=27 μg/mL), followed by MDAMB- 231 (IC50=40 μg/mL) breast cancer cells. Importantly, JFE exhibited only mild anti-proliferative effects against the normal MCF-10A (IC50>100 μg/mL) breast cells. Similarly, JFE (at 200 μg/mL) exhibited pro-apoptotic effects against the MCF-7aro ($p \leq 0.05$) and the MDA-MB-231 ($p \leq 0.01$) breast cancer

cells, but not towards the normal MCF-10A breast cells. These studies suggest that JFE may have potential beneficial effects against breast cancer.

Kumar *et al.*, (2008) found that Anti-diabetic activity of *Syzygium cumini* and its isolated compound against streptozotocin-induced diabetic rat's compound. Compound mycaminose was isolated from jamun seed extract. The isolated compound mycaminose (50 mg/kg) and ethyl acetate (EA) and methanol (ME) extracted compounds of *S. cumini* seed (200 and 400 mg/kg) was undertaken to evaluate the anti-diabetic activity against streptozotocin (STZ) - induced diabetic rates. The compound Mycaminose extracted in ethyl acetate and methanol extracted produced significant ($p<0.05$) reduction in blood glucose level. The standard drug, glibenclamide (1.25 mg/kg) also produced significant ($p<0.05$) reduction in blood glucose level against STZ-induced diabetic rats. The results of this experimental study indicate that isolated compound 'Mycaminose' from jamun seed extract with ethyl acetate and methanol possess anti-diabetic effects against STZ-induced diabetic rats.

Mastan *et al.*, (2008) found that effect of *Syzygium cumini* extract on the Albino rats. Three groups were orally received, 500 mg/kg body weight of methanolic extract of *Syzygium cumini* seeds (SME), gliclazide 2 mg/kg body weight, and SME prior to the administration of gliclazide 2 mg/kg body weight, respectively, in normal and diabetic rats. Blood samples were collected from the retro-orbital plexus at regular intervals after drug administration and were analyzed for blood glucose by glucose oxidase/peroxidase (GODPOD) method. Diabetes was induced by alloxan monohydrate 100 mg/kg body weight administered by (IP) route. Gliclazide produced hypoglycaemia/antihyperglycemia in normal and diabetic rats with peak activity at 2 hours and 8 hours. SME produced hypoglycaemia/antidiabetic activity when given alone, and prolonged the effect of

gliclazide in combination, in normal and diabetic rats without hypoglycaemic convulsions. The blood glucose levels of gliclazide were not altered in the presence of SME. The study indicated that the combination can be used safely to obtain prolonged and sustained antidiabetic effect.

Sheba *et al.*, (2010) studied that effect of jamun seed powder supplementation on the body mass index and fasting plasma glucose levels in women with type 2 diabetes mellitus. The group carried out study under the objectives to determine the effect of jamun seed powder supplementation on the Body mass index (BMI) and fasting plasma glucose (FPG) levels in women with type 2 diabetes mellitus (DM). This study included 30 women (30 – 45 yrs.) with type 2 DM and FPG levels greater than 126 mg/dl. They were equally divided into two groups as, Control group (n =15) without supplementation and Test group (n=15) with jamun seed powder supplementation. The study was conducted for a period of 60 days. The dosage of the jamun seed powder was 10gms per day. The biochemical parameter was estimated in a clinical laboratory. Statistically significant reductions were seen in the BMI of the women in both the groups. Significant reductions were seen in the BMI of the women in the control group by 1.3% compared to 2.8% in the test group. Statistically significant reduction was seen FPG in test group by 10.6% compared to an increment of 9.9% in the control group. Hence they concluded that jamun seed powder can be advocated as an effective hypoglycaemic agent in the management of diabetes mellitus.

Amin (2011) studied the secondary metabolites from seed extracts of *Syzygium cumini* (L.)and he isolated four compounds from the pet-ether and carbon tetrachloride soluble fractions of a methanol extract of seeds of *Syzygium cumini*. The structures of the isolated compounds were elucidated as 7-hydroxycalamenene (1), methyl-β-orsellinate (2), β-sitosterol (3) and oleanolic acid (4) through

extensive spectroscopic studies, including high-field NMR analyses. This report appears to be the first to identify 7- hydroxycalamenene (1) in *S. cumini* and the myrtaceae family, although it has been reported in cultured cells of the liverwort *Heteroscyphusplanus*.

Muniappan and Pandurangan (2012) investigated the phytochemical constituents and traditional uses of *Syzygium cumini(L.)*Skeels, is one of the widely used medicinal plants in the treatment of various diseases in particular diabetes. The plant is rich in compounds containing anthocyanins, glycoside, ellagic acid, isoquercetin, kaemferol and myrecetin. The seeds are claimed to contain alkaloid, jambosine, and glycoside jambolin or antimellin, which halts the dietetic conversion of starch into sugar. The vast number of literatures found in the database revealed that the extracts of different parts of jambolan showed significant pharmacological actions.

MATERIALS AND METHODS

Chapter–III

MATERIALS AND METHODS

The present investigation entitled "Anti-diabetic functional food product development using jamun and jamun waste" was undertaken in the Department of Food Engineering, College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (MS) India, during academic year 2012-2013.

3.1 Materials

3.1.1 Fruits

Fully matured, healthy and uniform size of jamun (*Syzygium cumini* Linn Skeels) was carefully selected for further experiments.

3.1.2 Chemicals

Chemicals like Petroleum ether, Hydrochloric acid, Sulphuric acid, 2,6-dichloro indophenol, Sodium hydroxide, Calcium chloride, Potassium permanganate, di-ammonium phosphate, Ethyl acetate, Methanol, Ethyl alcohol, Silica Gel, etc. analytical grade of S.D. Fine Chemicals Ltd, Delhi. These chemicals were procured from Department of Food Engineering and Department of Food Chemistry and Nutrition, College of Food Technology, VNMKV, Parbhani.

3.1.3. Processing equipment

The equipment's like steel utensils, grinder, knives, glass bottles, beakers, conical flasks, measuring cylinder, thermometer, refractometer, turbidometer, Brookfield viscometer, soxhlet apparatus, spectrophotometer, Low-pressure vacuum dryer, column chromatography, etc. These equipment's were utilised from Department of Food Engineering, College of Food Technology, VNMKV, Parbhani.

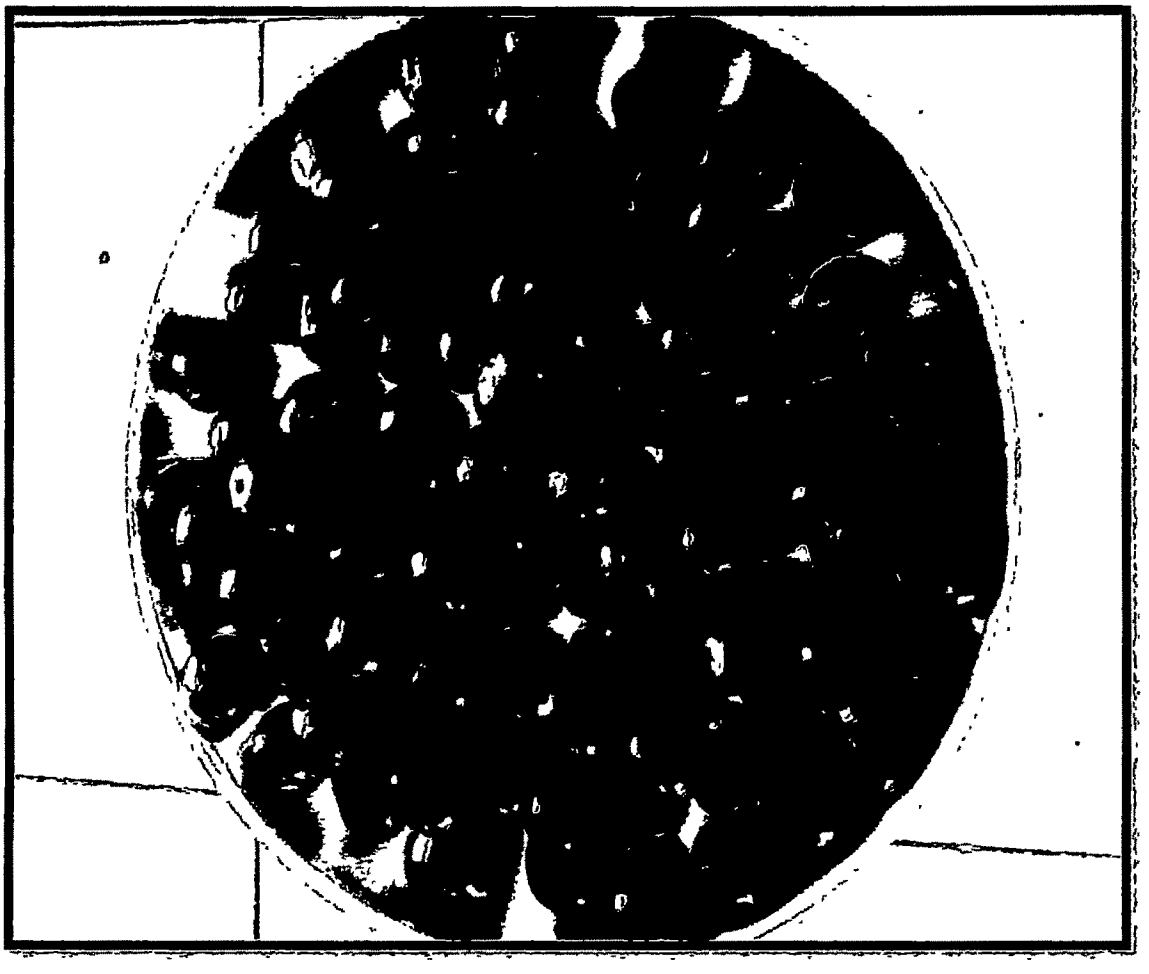

Plate 1 Jamun Fruits

3.2 Methods

3.2.1 Physical Characteristics of fresh fruits

3.2.1.1 Weight of fruits

The weight of 100 ripe fruits was noted and average weight of fruit was recorded.

3.2.1.2 Weight of pulp

The weight of pulp from 100 fruits was taken and average weight of pulp per fruit was recorded.

3.2.1.3 Weight of seed

The seed weight of 100 ripe fruits was taken and the average weight of seed per fruit was recorded.

3.2.1.4 Colour of fruits

Colour of fruit is visually monitored indicating it's ripening status.

3.2.1.5 Edible index

It is ratio of edible part of fruit to total weight of fruit multiplied by 100. Edible index was calculated and expressed in percentage.

3.2.1.6 Waste index

It is ratio of waste part of fruit to total weight of fruit multiplied by 100. Waste index was calculated and expressed in percentage.

3.2.1.7 Viscosity

The viscosity of the jamun juice was determined at room temperature (25°±5°C) using Brookfield viscometer (Model No RV 20 /United States) at 30 rpm with spindle no 2 Checked to confirm that the viscometer had been calibrated. The sample container and quantity was taken 150 ml for the Calibration Standard. Equilibrate the temperature of the sample to the temperature designated in the specification (±1°C). Confirm that the viscometer is levelled using the bubble level

indicator on the back of the instrument. For the Brookfield RV-II, AUTO ZERO the instrument with number spindle attached and the speed set as designated in the product specification. The instrument Brookfield viscometer RV-20 was attached with the spindle no 2, made to auto zero and then was set with the desired speed units. The instrument flashed "0.00" on display screen after 10 seconds. The spindle was immersed in the sample with beaker such a way that spindle's shaft groove is reaches to the upper layer of sample in a beaker. A care was taken that spindle does not touch the walls or bottom of the beaker. The reading was noted from dial and a manual conversion chart was used to convert the reading to centipoise (Cp). Each sample was measured for three readings. After every sample measured for its viscosity, the spindle was cleaned and removed to place in spindle holder.(Lee *et al.*, 2006).

3.2.1.8 Turbidity

Turbidity of juice was measured using turbidometer (MAC^R, Model No 66120-200, India). The turbidometer was calibrated using the 0.02nephlometric unit (NTU) Reference Standard. Allow samples to come to room temperature 25 °c before analysis. The turbidometer was placed in Ac rooms to maintain temperature at 25±1°C. The sample was mixed thoroughly to disperse the solids. After dispersion allows a moment until air bubbles disappear before dispensing sample into a cuvette. Gently agitated the sample to re-suspend any heavier particles without introducing air bubbles.Filled a clean, indexed sample cuvette to within approximately ½ inch of the top level with a sample aliquot directly from the churn splitter or from a sample bottle. Placed the cap on the cuvette and carefully cleaned any condensation from the outside of the cuvette with a lint free wiper such as Kimwipes (Condensation was prevented by coating the outside of the cuvette with

a small amount of silicon oil). Placed the sample cuvette into the well, aligned with the locator pin on the optical and took the NTU reading directly from the display. Selected the appropriate display range for best resolution. Read the turbidity within 3-5 seconds. The reading of blank sample was taken and then sample was put into cuvette and results were recorded in nephelometric units (NTU) at 625 nm (Liew *et al.,* 2007).

3.2.1.9 9 Yield of fruit pulp

The selected sample of jamun fruit was first weighed. Fruits were cut to separate the non-consumable part (seed) from the consumable portion (pulp). The pulp adhered was scrapped from seed to bring back to the former part. Then the consumable pulpy matter was weighed. The percentage of pulp was calculated by the following formula:

$$\text{Per cent fruit pulp} = \frac{\text{Weight of extracted matter (g)}}{\text{Weight of whole fruits (g)}} \times 100$$

3.2.2 Chemical analysis

3.2.2.1 Determination of moisture

Moisture was estimated by grinding the sample with grinder. Weighed 5 g sample accurately with digital balance and subjected to oven (Model No. STE-25, EI Shaddai Instruments Manufacturer, Mumbai/Delhi India) anddried at 105°C for 8 hours. It was again weighed after cooling in desiccators until got the two consecutive constant reading. The resultant loss in weight was calculated as moisture content (A.O.A.C., 1990).

3.2.2.2 Determination of Total Soluble Solid (T.S.S.)

Total soluble solids were measured by using hand refractometer (Model no SK-109R, Erma Instruments Manufacturer of India) of range 0°Bx to30°Bx and reported as °Bx (Rangana, 1979).

3.2.2.3 Determination of pH

Pulp of fruit of 5gm was taken and equal quantity of water mixed and pH of prepared sample was measured by laboratory pH meter of model YO 58901, AE Max Instruments Manufacturer of India. (Rangana, 1979).

3.2.2.4 Determination of total ash

Sample (5 g) was weighed into preheated and cooled crucible which was heated at low flame till all the material was completely charred to smokeless. Then it was kept in preheated muffle furnace for about 4 hours at 600°C. It was again cooled in desiccators and weighed and repeated until two same consecutive reading were obtained. The per cent ash was calculated by knowing the difference between the initial and final weight (A.O.A.C., 1990).

3.2.2.5 Determination of protein

Protein was determined by Micro-Kjeldahl method using 0.5 g of dried ground sample by digesting the same with concentrated sulphuric acid (H_2SO_4) containing catalyst mixture (99g of HgO red and 0.8g $CuSO_4.H_2O$) for 30 - 40 min at 70°C. Then it was distilled with 40 per cent NaOH and liberated ammonia was trapped in 4 per cent boric acid and then it was titrated with 0.1N HCl using mixed indicator (Methyl red : Bromocresol green, 1:5). The per cent nitrogen was calculated and protein percentage was estimated in the sample by multiplying with factor 6.25 (A.O.A.C., 1990).

$$\text{Nitrogen (\%)} = \frac{\text{(Sample titre – Blank titre) x normality of HCl x 14 x 100}}{\text{Weight of sample x 1000}}$$

Protein (%) = Nitrogen (%) x 6.25

3.2.2.6 Total sugars

Determination of sugars (total sugar, reducing sugar and non-reducing sugar) was carried out through Lane and Eynon Method as described by James (1995). **Total sugar and reducing sugar:** Took 5 g of sample into a beaker and added 100 ml of warm water. The solution was stirred until all the soluble matters were dissolved and filtered through wattman no. 1 filter paper into a 250 volumetric flask. Pipette 100 ml of the solution into a conical flask to make up volume, added 10 ml diluted HCl and boiled for 5 min. On cooling, neutralized the solution using10% NaOH and phenolphthalein indicator and made up to volume in a 250 volumetric flask. This solution was used for titration against Fehling's solution and reading was calculated as follow.

$$\text{Total sugars (\%)} = \frac{\text{Factor (4.95) X dilution (250) X 2.5}}{\text{Titre X wt of sample X 10}}$$

$$\text{Reducing sugar (\%)} = \frac{\text{Factor (49.5) X dilution (250)}}{\text{Titre X wt of sample X 10}}$$

Non-reducing sugar was estimated as the difference between the total sugar content and reducing sugar content.

3.2.2.7 Determination of titrable acidity

The per cent acidity was determined as per procedure given by Ranganna (1979) by titrating sample against 0.1N sodium hydroxide (NaOH) using phenolphthalein as an indicator and per cent total acid were calculated by using given formula.

$$\%\text{Total Acidity} = \frac{\text{Titer value} \times \text{normality of alkali} \times \text{volume made up} \times \text{eq.wt. Of acid} \times 100}{\text{Volume of sample taken for estimation} \times \text{wt. of sample taken initially} \times 1000}$$

3.2.2.8 Determination of ascorbic acid

Ascorbic acid content was determined by titrating a 10 ml of sample with 2, 6-dichlorophenol indophenol dye using oxalic acid.

The 2, 6-dichlorophenol dye which is blue in alkaline solution and red in acid solution reduces ascorbic acid to a colourless form. Ascorbic acid is expressed as mg/100g by using given formula (Rangana, 1979).

$$\text{Dye Factor} = 0.5/\text{Titre}$$

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre} \times \text{Dye factor} \times \text{Volume made up} \times 100}{\text{Aliquot of extract taken for estimation} \times \text{wt. or volume of sample taken for estimation}}$$

3.2.2.9 Total anthocyanin

Buffer preparation

In the extract preparation process, first the pH 1 buffer containing 125ml of 0.2M KCl(14.9g/l) and 335ml of 0.2M HCl.

The pH 4.5 buffer containing 400ml of 1M sodium acetate (136g/l) and 240ml of 1M HCl (83.0 ml concentrated HCl) and 360ml distilled water were developed. The pH of the buffers was adjusted as required to obtain final pH values of 1 and 4.5.

Preparation of the samples

The 10 ml prepared jamun juice was diluted with 50 ml of each pH 1 and pH 4.5 buffers. Further its degree of absorption of Cyanidin-3-goflocoside was determined by means of Shimadzu spectrophotometer (Model UV120-02, Japan).

The measurement of anthocyanins by pH differential method

The absorption of the samples developed through pH 1 and pH 4.5 buffers was measured in terms of Cyanidin-3-glycoside pigment at 510nm by means of a spectrometer (Ranganna, 1979).

3.2.2.10 Determination of crude fibre

The reagent used were sulphuric acid solution (0.255 ± 0.005 N): 1.25 g concentrated sulphuric acid diluted to 100 ml (concentration must be checked by titration). Sodium hydroxide solution (0.313 ± 0.005 N): 1.25 g sodium hydroxide in 100 ml distilled water (concentration must be checked by titration with standard acid). 2 g of moisture and fat free sample was treated with 200 ml of 1.25% $H_2SO_4$for 30 min and then filtration is carried out with wattman filter paper No. 4 and washing the residue was treated with 1.25% NaOH. It was filtered, washed with hot water and then 1% HNO3 and again with hot water. The residue was ignited and the ash weighed. Loss in weight gave the weight of crude fiber (Chopra and Kanwar, 1991 and Mazumdar and Majumder, 2003).

$$\text{Crud fibre (\%)} = \frac{(c - b) - (d - b)}{(a)} \times 100$$

Where; a = weight of sample; b = weight of crucible; c = initial weight of crucible containing tissue sample before ignition and d = final weight of crucible containing ash after ignition.

3.2.3 Preparation of the jamun juice

Well ripened, good quality fresh jamun fruits procured from local market were used as process-able raw material. The selected fruits were cleaned under running tap water. Uniform ripening is suitable for good quality juice preparation. The quality of ripeness of jamun fruits weremonitored by conventional means i.e. thumb pressing and surface discoloration. 1 kg of good quality well ripened jamun fruits were taken as experimental material. First fruits were boiled for 15 min in 1.5 lit water for softening. After boiling these fruits were cooled by deeping into the cold water and seeds were removed by pressing the fruit. Inedible portion of the fruits was weighed to calculate waste index. The deseeded fruits were grounded into the mixer with the and this pulp is used for the preparation of the jamun juice.

Juice extraction

A known quantity (100g) pre-processed fruit pulp was taken in a 500 ml beaker. 50 ml of the water then added with in to the pulp.

The liquefied pulp was taken for the extraction of the juice with the help of double layer muslin cloth. The pulp was passed through the double layer muslin cloth and juice was extracted by pressing and decanting. Sparkling clear juice obtained were added with sodium benzoate for the preservation of the jamun juice at the rate of 250 ppm. Clarified juice was pasteurized at 60°C for 2 min, filled in glass bottles and processed in boiling water for 2 min. Bottles were stored at temperature below 10°C. (ArunachalamNanadaa Kumar., 2009)

Sparkling clear juice obtained was assessed for the turbidity at 420 nm, viscosity by Brookfield viscometer.

Flow sheet-1: Procedure of fruit juice manufacturing

Whole fruits (Physiologically fresh, graded and well ripened) 1 kg

↓

Tie in muslin cloth

↓

Boiling the fruits with water (2 litre) for 15 minutes

↓

Cool the fruits in the cold water

↓

Removal of the seeds from the fruit by hand peeling

↓

Ground the deseeded fruits into the mixer with added water (500 ml)

↓

Production of pulp

↓

Filtration with the double layer muslin cloth

↓

Clarified juice (1.1 litre of juice) pasteurized at 60° C for 2 min

↓

Filled in glass bottles and processed in boiling water at 90°C water for 2 min.

↓

Bottles were stored at temperature below than 10°C.

3.3 Preparation of Alcoholic Jamun seed extract

The well ripened fresh jamun fruits procured from local market. The seeds were separated from the jamun fruits. The seeds were dried in shade and stored at 25°C. Seeds are cream coloured, coriaceous, covering, smooth, oval or roundish. Each fruit contains a single seed 1 to 2 cm long. The whole seed enclosed in a cream coloured coriaceous covering, smooth oval or roundish. The seeds were dried at room temperature and grounded into the powder using the electrical grinder (Ken star, 18000 rpm, and 600 watt) and stored in air tight bottles.

The seed powder (10 gram) was extracted in a soxhlet with 95% ethanol at a temperature 50°Cfor 12 h. The resultant extract was filtered. The filtered extract was then concentrated to dryness in a rotary vacuum evaporator under reduced pressure at a temperature of 40°C. The dried mass (500 mg) was obtained from of seed powder. This extract was stored in a refrigerator.

3.4 Organoleptic Evaluation of Jamun juice with added seed extract

Freshly prepared jamun juice were evaluated for sensory characteristics like colour, flavour, taste, mouth feel and overall acceptability at room temperature by panel members on 9- point Hedonic scale.

The sensory evaluation of beverage was carried out by a 10 member semi-trained panel comprised of experienced academic staff members of College of Food Technology, Parbhani. Judgments were made through rating products on a 9 point Hedonic Scale with corresponding descriptive terms ranging from 9 'like extremely' to 1 'dislike extremely'. The obtained results were recorded in sensory score card.

The format of sensory score card is given in Appendix I.

3.5 Cost of production

The production cost of prepared jamun juice with enriched jamun seed extract was calculated by considering cost of individual ingredients with 20 per cent processing cost and the packaging cost. The cost is expressed in Rupees.

3.6 Energy value of the juice

The energy value of the jamun juice is calculated by multiplying the nutritional components like carbohydrate, protein, fat with their standard calorific values by 4, 4 and 9 respectively.

3.7 Statistical analysis

The analysis of variance of the data obtained was done using Completely Randomized Design (CRD) for different treatments as per the methods given by Panse and Sukhatme (1967). The analysis of variance revealed at significance of $P < 0.05$ level, S.E. and C.D. at 5 % level is mentioned wherever required.

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The purpose of present investigation is to develop a technology of preparation of anti-diabetic functional product viz. Jamun juice by using jamun and jamun waste (seed). Jamun seeds were extracted with 95 per cent ethanol and this powder form of extract was further used in different proportion (up to 2.2 per cent) in jamun juice. The prepared jamun juice with its extract was analysed for physico-chemical properties and sensory characteristics.

The results obtained during the present investigation are presented and depicted in the following headings and subheadings:

4.1. Anatomical properties of jamun fruit
4.2. Physico-chemical properties of jamun fruit
4.3.Physico-chemical properties of jamun seed
4.4. Chemical properties of jamun fruit pulp
4.5.Physico-chemical properties of jamun fruit juice
4.6. Nutritional composition of the jamun seed powder
4.7. Standardization of recipe for preparation of jamun juice
4.8. Organoleptic evaluation of jamun fruit juice with added seed extract
4.9. Nutritional Composition of the jamun juice with the added seed extract
4.10. Techno-economic feasibility of jamun juice with seed extract
4.11. Theoretical energy value of the jamun juice with added seed extract

4.1 Anatomical properties of jamun fruit

The yield of anatomical parts of jamun were calculated and presented in table 1.

Table 1: Anatomical content of jamun fruit

Anatomical parts	Yield (%)
Pulp	64
Kernel	31
Seed coat	5

The procured jamun fruit had appreciable amount of pulp (64 per cent) which is useful to prepare juice.

The results of present investigation for jamun fruit related to anatomical parts are in close agreement with the finding of Garande (1992).

4.2 Physico-chemical Properties of jamun fruit

The physical factors of the jamun fruits are very important for the determination of the quality of the jamun fruit. The physical factors like the good average size shape, colour represents the healthy characteristics of the jamun fruit and the colour is indicator of the ripening of the fruit.

Physical features of fresh fruits were characterized by their specific colour, shape, weight/fruit etc. All these characteristics were studied and average values of the five determinants were reported in table 2.

It is evident from Table-2 that, Jamun fruit was deep purple-blackish in colour with elliptical capsule and oblong in shape. The colour variation may be due to the change in variety of the fruit. The study of the shape as a physical feature of a fruit has its importance to determine whether it conforms to the standards. Any

Plate 2 Jamun seeds

Plate 3 Jamun seed powder

deviation that may result due to interacting factors like environment, biotic agencies or application of agro-inputs to the trees bearing that fruit with respect to fruit also forms an important part of shape study. Fruits belonging to a species or a variety of it have some characteristic shape of their own although small variations are not considered to be an uncommon feature.

Table No 2: Physico-chemical properties of jamun fruit

Parameter	**Jamun fruit**
Colour	Purple to black
Shape	Oblong/ elliptical
Weight per fruit (gm)	11.8
Firmness/softness	Moderately soft
Length of fruit (cm)	2.73
Volume of fruit (ml)	11.02
Specific gravity (value)	1.25
Total Soluble Solids (TSS)°Brix	15
Titrable acidity (%)	1.58
pH (value)	3.77
Moisture content in fruit (%)	80
Edible index (%)	64

*Each value is a mean of three determinations

The average weight per fruit was 11.8 gm, the average length of the fruit was 2.7 cm, and average volume of the fruit is 11.02 ml. It can also be seen that Jamun contained lower percent of waste in the form of seed. Owolarafe and Shotonde (2004) described that firmness of a healthy fruit is linked to the degree of its physiological maturation. The fruit undergo gradual softness to a greater or a

lesser extent depending on species, varieties, environment and enzymatic changes into the fruit with progress of development, maturation and ripening either in the pre-harvest or in the post harvest condition. Jamun fruit is moderately soft and softness is varied according to maturation and development in the ripening. Specific gravity of the jamun fruit is 1.25. The total soluble solid of the jamun fruit-pulp is 15°bx and the titrable acidity of the pulp is 1.58 per cent. The pH value of the pulp is 3.77 and the pH values revealed that fresh extract of jamun fruit is highly acidic and responsible for astringency in taste.

The moisture content of the fruit is 80 per cent and edible portion of the jamun fruit is 64 per cent.

The results of present investigation for jamun fruit related to physical properties are in close agreement with the finding of Muhammad *et al.* (2009).

4.3 Physico-chemical properties of jamun seed

Table No 3: Physico-chemical properties of jamun seed

Parameter	**Jamun seed**
Colour of seed	Cream colour
Seed per cent in fruit	36
Moisture content in fresh seed (%)	45
Moisture content in dried seed (%)	12.34

The colour of the jamun seed is cream colour, Many jamun varieties are found to be seedless (eg.varanasi). The moisture content of the dried jamun seed is 12.34 per cent. The moisture content of the fresh seed was found to be 45per cent.

The waste index of jamun 36 per cent this is considerably high as compare to other fruits because of seed weight. The seed percentage of the jamun changes according to change in varieties.

The contents of TSS, pH, acidity, edible index of jamun fruit are very important in preparation of jamun juice, whereas results also showed that jamun fruit contained 36 per cent seed. Jamun seed had a therapeutic and nutritional value as seeds contains good source of alkaloids, glycoside, jamboline, gallic acid, essential oils. The seed contain a functional anti-diabetic component Mycaminose. The possible mechanism by which seed brings about a decrease in blood sugar level may be potential of the insulin effect of plasma by increasing either the pancreatic secretion of insulin from beta-cells of the islets of Langerhans or its release from the bound form. A number of other plants have been reported to exert hypoglycaemic activity through insulin release-stimulatory effects (Twaij and Al-Badr, 1988; Gupta, 1994). Thus its extract was prepared and further used in preparation of jamun juice especially as antidiabetic and functional food.

4.4 Chemical properties of fruit pulp

The chemical parameters of jamun pulp *viz.* moisture, total soluble solids, pH, acidity, total sugar, protein, ascorbic acid and anthocyanin were determined and results obtained were presented in Table-3.

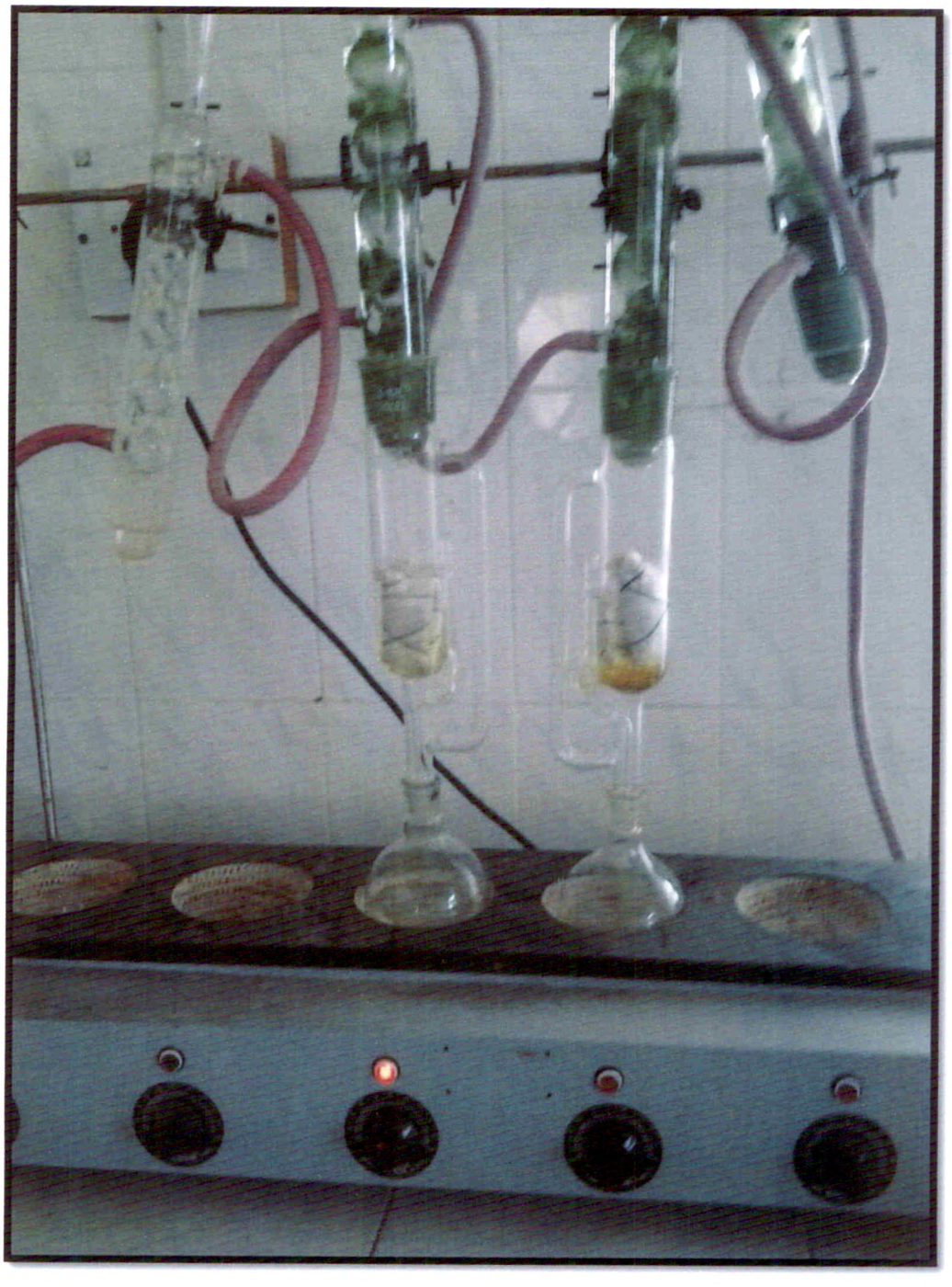

Plate 4 Alcoholic extraction of Jamun seed Powder

Table 4: Chemical properties of fruit pulp

Constituents	Jamun fruit pulp
Moisture (per cent)	83
T.S.S. (°Bx)	15
Titrable acidity (per cent as citric acid)	1.28
Total Ash (per cent)	0.31
Ascorbic acid (mg/100g)	55
Protein (per cent)	0.7
Total sugar (per cent)	16.05
Anthocyanin (mg/100g)	180.25

*Each value is a mean of three determinations

From the above table moisture content of fruits pulps was found to be 83 percent. TSS of jamun fruit pulp was found to be 15°Bx with titrable acidity 1.28 per cent and other constituent *viz.* total sugar, protein, ascorbic acid and total ash 16.05 per cent, 0.7 per cent, 55 mg/100g, and 0.31 per cent respectively. The results obtained are in good agreement with the results reported by (Khurdiya and Roy, 1985).

TSS of extracted jamun pulp was found to be15°Bx helps in preparation of jamun juice and also pulp contained good amount of ascorbic acid and anthocyanin content which impart a pleasant taste and attractive acceptable colour to jamun juice with their functionality importance.

4.5Physicochemical properties of jamun fruit juice

The jamun juice was prepared from extracted jamun pulp as per the process adopted by Arunachalam Nanadaa Kumar (2009) and this jamun was analysed for its physico-chemical properties and results are reported in table 4.

Table 5: Physicochemical properties of jamun fruit juice

Parameters	Jamun juice
Colour	Purple
T.S.S (°Bx)	13
Titrable Acidity (%)	1.20
pH	3.60
Yield (%)	64
Total sugar (%)	15.8
Viscosity (cP)	12.2
Turbidity at 420 NTU	136
Ascorbic acid (mg/100gm)	42
Anthocyanin (mg/100gm)	160

*Each value is a mean of three determinations

It could be observed from the Table 5 that in case of jamun fruit juice was having deep purple colour with TSS 13°Bx, pH value 3.60, titrable acidity 1.20 per cent. The total sugar content of jamun juice was 15.80 per cent, ascorbic acid content was 42 mg/ 100g and anthocyanin content is found to be 160mg/100g. The viscosity and turbidity of jamun juice was 12.2cP and 140 NTU (at 420 nm) respectively.

The data obtained are in agreement with the results reported by Shahnawaz *et al* (2009).

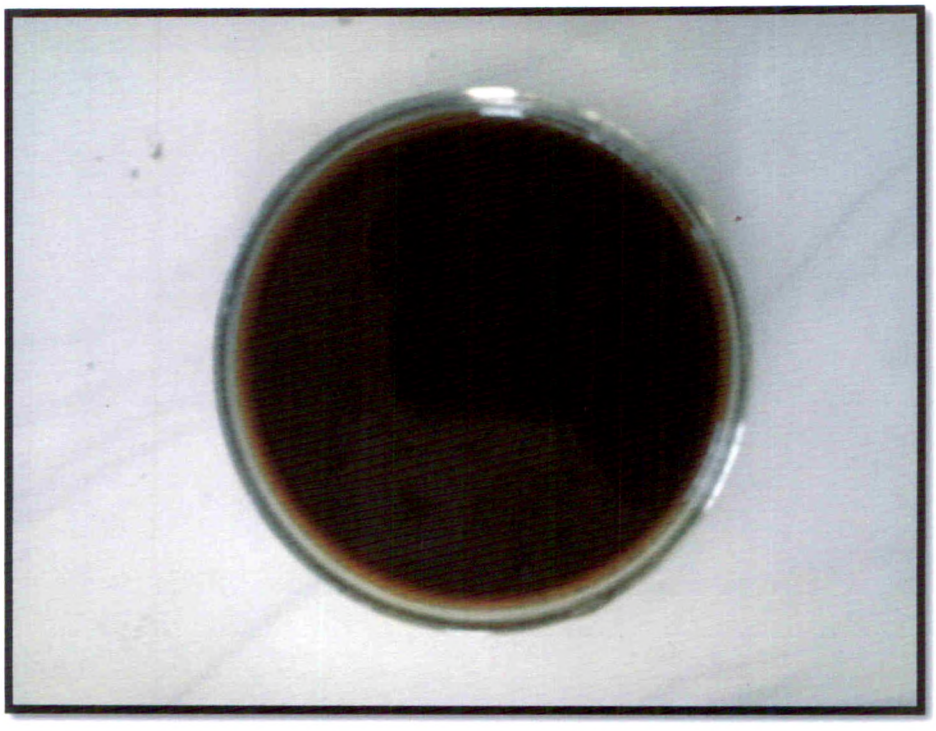

Plate 5 Alcoholic seed extract

Plate 6 Jamun juice with seed extract

4.6 Nutritional composition of the jamun seed powder

Table 6: Composition of the jamun seed powder

Parameters	Shade dried seed powder	Sun dried seed powder
Ash (%)	18.1	18.11
Vit. C mg /100g	0.81	0.45
Reducing Sugar (%)	1.23	1.31
Non Red. Sugar (%)	1.74	2.22
Total sugars (%)	3.16	3.54
Carbohydrate (%)	72.37	73.71
Protein (%)	5.17	4.57
Fats (%)	0.9	0.68
Total Solids (%)	96.5	97.07
Crude fibre (%)	12.44	12.48

The jamun seed powder is prepared by two types one by drying the seeds in shade and other by sun drying. From the above table the composition of the jamun seed powder by shade drying was found to be 18.1per cent ash, 0.81 mg /100gvitamin C,1.23 per cent reducing sugar, 1.74 per cent non reducing sugar, 3.16per cent total sugars, 72.37per cent carbohydrate, 5.17per cent protein, 0.90per cent fats, 96.5 per cent total solids, 12.44 per cent crude fibres.

On other hand the composition of the jamun seed powder prepared by the sun drying was found to be the 18.11 per cent ash, 0.45 vitamin C mg /100g, 1.31 per cent reducing sugar, 2.22 per cent non reducing sugar, 3.54 per cent total sugars, 73.71 per cent carbohydrate, 4.57 per cent protein, 0.68 per cent fats, 97.07 per cent total solids, 12.48 per cent crude fibres.

Plate 7 Turbidity meter

Plate 8 Brookfield viscometer

It can also seen from table that vitamin C, protein and fat content was slightly decreased in sun drying as compare to shade drying. This may be due to denaturation of vitamin C at high temperature than shade drying.

Thus above table shows the slight difference between the compositions in the jamun powder prepared by the two methods and the composition of the seed powder changes slightly as the change in the drying methodology as there is change in the final moisture content of the jamun seed powder and other means of processing factors. The above values are found to be approximately similar with the research done by the Shahnawaz *et al* (2009).

4.7 Standardization of recipe for preparation of jamun juice

The clarified jamun fruit juice was prepared by using jamun seed extract with variable proportion of Jamun juice with water and the standard recipe is tabulated in table no 7.

Table no 7: Formulation of recipe of jamun juice

Composition Sample	Jamun juice (%)	Seed extract (%, w/v)	Water (%)
Control	60	0	40
Sample A	60	1.8	38.2
Sample B	60	2	38
Sample C	60	2.2	37.8

The formulation of recipe of preparation of jamun juice was standardized by addition of 1.8, 2 and 2.2 per cent ethanol extracted seed powder in sample A, B and C respectively. Whereas the per cent of jamun juice (60 per cent) was kept constant with slight variation of water related to per cent use of seed extract

powder. The jamun seed extract of (1.8 to 2.2 per cent) was selected as per the dose recommended by P. Stanely Mainzen Prince *et al.*; He selected six groups of the induced diabetes rat. Group 1, control normal rats given 2 ml of saline; Group 2, diabetic rats given 2 ml of saline; Group 3, diabetic rats given alcoholic JSE (25 mg kg−1) suspended in saline daily using an intra-gastric tube for 42 days; Group 4, diabetic rats given JSEt (50 mg kg−1) daily for 42 days; Group 5, diabetic rats given JSEt (100 mg kg−1) daily for 42 days; Group 6, diabetic rats given protamine zinc insulin (6 IUkg−1) intraperitoneally daily for 42 days.

The blood glucose and urine sugar were significantly elevated in diabetic rats as compared to normal rats. Oral administration of alcoholic JSEt at 25 and 50 mg kg−1 body weight significantly lowered the blood glucose and urine sugar as compared to untreated diabetic rats. JSEt at a dose of 100 mg kg−1 body weight restored the blood glucose and urine sugar to normal levels. Since 100 mg kg−1 body weight of JSEt showed the highest blood glucose lowering effect, we have taken only 100 mg kg−1 body weight of JSEt for our further studies.

The selected doses of seed extract are also effective as a nutraceutical value by reducing diabetic blood glucose level.

The possible mechanism by which seed brings about a decrease in blood sugar level may be by potential of the insulin effect of plasma by increasing either the pancreatic secretion of insulin from Beta-cells of the islets of Langerhans or its release from the bound form. A number of other plants have been reported to exert hypoglycaemic activity through insulin release-stimulatory effects (Twaij and Al-Badr, 1988; Gupta, 1994).

4.8 Organoleptic evaluation of jamun fruit juice with added seed extract

In order to develop the anti-diabetic functional food product from jamun juice and the seed extract at different proportions are used as given in table 8. The formulated and prepared jamun juice with seed extract was further evaluated by 9 point hedonic scale with 10 semi trained panel member for different sensory attributes like, colour, appearance, taste, flavour, mouth feel and for overall acceptability. Trials were intended to standardize the level of fruit juices to seed extract to have benefits from nutritional point of view.

Table 8: Organoleptic evaluation jamun juice prepared with different levels of seed extract:

Sensory parameters	Colour and appearance	Taste	Flavour	Mouth feel	Overall acceptability
Control	8.50	8.00	8.00	8.00	8.20
A	8.20	8.00	8.00	7.80	8.00
B	8.70	8.20	8.20	7.80	8.30
C	8.00	8.00	7.80	7.50	7.90
SE±	0.118	0.114	0.077	0.087	0.105
CD at level 5%	0.348	0.336	0.228	0.257	0.308

Code of samples –

Control: Jamun pulp: seed extract: water (60:00:40)

A: Jamun pulp: seed extract: water such as (60:1.8:38.2)

B: Jamun pulp: seed extract: water such as (60:2:38)

C: Jamun pulp: seed extract: water such as (60:2.2:37.8)

Table-8 summarizes the effects of various proportion of the seed extract on sensorial quality parameters of prepared jamun juice. It is evident from Table 7 that sample B having blending ratio 60:2:38 was significantly superior in colour, flavour and taste over A and C. A good quality jamun juice with the seed extract of 2 per cent had acceptable colour, flavour and mouth feel. It also showed from table that sample B having 2 per cent seed extract in jamun juice recorded highest score in all organoleptic attributes and found to be overall acceptable. However the values of taste, flavour and mouth feel was slightly decreased but acceptable. However sample A having 1.8 per cent seed extract was reported slightly decreased organoleptic score in all attributes as compare to sample B, but sample C recorded least acceptable score in all the organoleptic attributes. The increase of seed extract more than 2 per cent decreased the organoleptic score as seed powder may imparts its own taste, flavour and mouth feel in jamun juice.

The sample B (60:2:38) was found to be statistically significant in colour and appearance, and overall acceptability as compare to the sample A and C whereas in other organoleptic attributes sample B recorded similar score. Hence sample B was found to be overall acceptable.

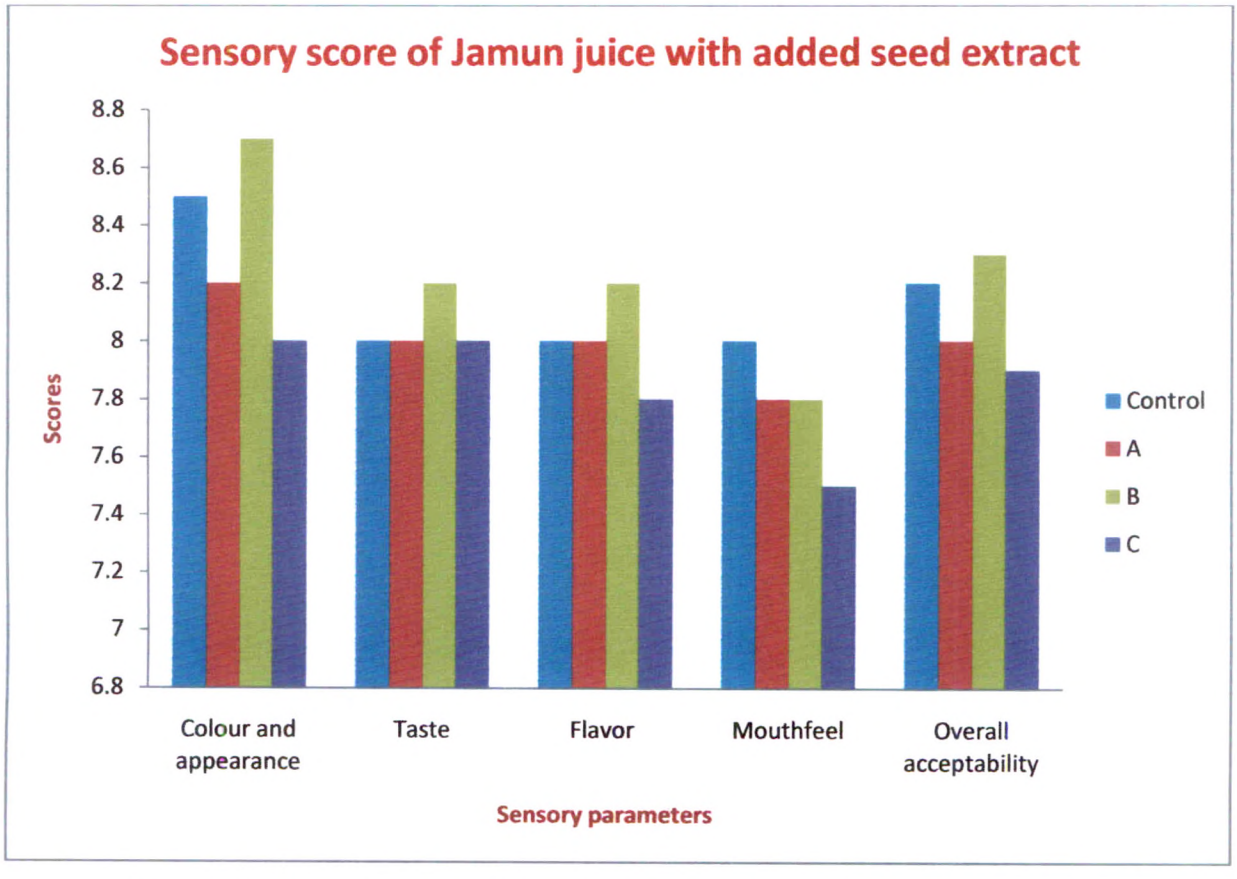

Fig. 1- Sensory score of Jamun juice with added seed extract

4.9 Nutritional Composition of the jamun juice with the added seed extract

The composition of the jamun juice with the added seed extract is shown in the following table 8.

Table 9: Nutritional Composition of the jamun juice with the added seed extract:

Nutrient	Percentage (%)
Moisture	83.5
Protein	0.7
Fat	0.1
Fibre	0.9
Carbohydrate	12.8

Sensory evaluation showed that sample B is most acceptable with seed extract being 2 per cent in the composition. Hence this sample provides enough seed extract dose to the consumer which helps to lower the blood glucose level of the diabetic person. Hence Sample B was for determination of the nutritional composition.

From table no. 9 the jamun juice content 83.5 per cent of the water, the protein content and the fat content in the product was in very minute quantities as 0.7 per cent and 0.10 per cent. The carbohydrate content of the jamun juice was 12.8 per cent. The fibre content of the jamun juice is very less (0.9) per cent.

Proximate nutritional composition among prepared jamun juice with seed extract was not much promising but this juice is having a great therapeutic value and nutritional value as an anti-diabetic juice. The analysis of above constituents are useful in determining energy value (K cal) of prepared juice as it is anti-diabetic it must provide low calorie to the subjects.

4.10 To study techno-economic feasibility of jamun fruit juice with ethanolic seed extract

Table 10: Production cost of the jamun fruit juice with the added Seed extract

Sr. No	Material required	Quantities	Rates (Rs.)	Amount (Rs.)
1	Jamun fruit	10 Kg	40/kg	400
2	Jamun fruit juice	7.6 lit	----	----
3	Ethanol	300 ml	520/500 ml	312
4	Processing cost (20 per cent of raw material)	----	----	80
5	Jamun juice with seed extract	12.66 lit	----	----
6	Glass bottles	13	10	130
7	Total Production cost of 12.66 lit	---	---	922
8	Production Cost / 1 litre bottle	---	---	72.80

Table 10 shows that cost of production of 1 litre jamun juice enriched with seed extract is Rs 72.80 per litre of finished juice. Jamun fruit is a main ingredient incurring major cost and processing cost of 20 per cent and packaging cost also included into the production cost of the finished product. It can be seen from the table that the production of 12.66 litre of jamun juice account for 922 as a production cost hence the production cost of the 1 litre juice is 72.80.

The 10 Kg of jamun fruits produces 7.6 litre jamun juice and the enriched jamun juice with the seed extract was prepared with addition of water in a desired quantity such that a person can drink without addition of any sweetener. The pure jamun juice has very astringent taste hence desired proportion of water must added to the juice to standardise the juice. The 60 parts of the jamun juice and 40 parts of water added was most acceptable jamun juice and hence addition of 40 parts of water to juice produces 12.66 litre juice. Thus total 12.66 litre juice was prepared from 10 kg fruits. Ethyl alcohol was also a major costly chemical but this can be reused again hence the production of the seed extract on commercial scale helps to gives more profit than the laboratory scale.

Thus from the above table we conclude that the production of the jamun juice with the added seed extract is economically feasible and it can gives good profit to the producer. It has good medicinal value hence it can help to lower down the blood glucose level of the diabetic patients.

It is evident from the table that the cost of prepared jamun juice enriched with seed extract was found to be same as that of commercial marketed fruit juices, additionally this product provides high therapeutic and nutraceutical value to the consumer.

4.11Theoretical energy value of the jamun juice with added seed extract:

Table no. 11: Energy value of prepared jamun juice with jamun seed extract (per 100 ml)

Macronutrient	Nutritional composition	Energy per gram	Energy value
Carbohydrate	12.8	4	51.2
Protien	0.7	4	2.8
Fat	0.1	9	0.9
Total energy value			54.9

Table 11 shows that the energy value of developed jamun juice enriched with jamun seed extract is found to be 54.9 K cal/ 100 ml. Although the energy value of existed commercial fruit drinks was higher. The prepared juice was found to be very effective for diabetic personals as reported low energy value than commercial fruit drinks.

SUMMARY AND CONCLUSION

Chapter V

SUMMARY AND CONCLUSION

Jamun fruit is considered to be the potential source of the nutraceutical containing the mallic acid, oxalic acid, gallic acid, ellagic acid, betulic acid, tannins, flavonoids and essential oils. These compounds are present at the different parts of the tree and can either act in combination or individually to cure some diseases and health problems. Different parts of jamun are used as an alternative medicine for the treatment of diabetes. One of the very common traditional uses of jamun is the powdered seed jamun for controlling the blood sugar level in diabetic patients. The seeds are rich in proteins and calcium. The glycoside Jamboline is the main compound found in the seed which helps in controlling the blood sugar level by switching off the mechanism of starch converting to sugar when there is optimum amount of sugar already present in the blood.

The purpose of the present investigation is to develop the technology for preparation "Antidiabetic functional food product development using jamun and jamun waste" was carried out in the department of Food Engineering during the academic year 2012-13.

In the present investigation the jamun seed extract was prepared by using 95 per cent ethanol with soxhlet extraction method and this jamun seed extract was further used for preparation of jamun juice with different proportions of seed extract. Further physico-chemical and sensory characteristics studies were carried out and the results obtained during this investigation are summarized accordingly as follow.

The color of the jamun fruit is purple to black having average weight of the fruit is 11.8 gm. The texture of the fruit is moderately and changes according to the ripening of the fruit. The jamun fruit contain 80 per cent moisture, 15^0Bx total soluble solids, 1.58 titrable acidity and 3.7 pH.

The jamun fruit haves been found with 64 per cent pulp, kernel 31 per cent and the seed coat is 5 per cent. Hence the jamun fruit is suitable for the preparation of the RTS as contained sufficient amount of the pulp.

The jamun fruit pulp contains 83 per cent moisture, 15°Bx, 1.28 titrable acidity and the total ash contain is 0.31 per cent. The ascorbic acid, anthocyanin content of jamun pulp is 55 and 180 mg/ 100g respectively.

The moisture content of jamun fruit is in the range of 80 to 84 per cent. The moisture content of the fresh seed is found to be 45 per cent and the dried seed was 12.34 per cent.

In terms of nutraceutical properties for jamun fruit was found to contain ascorbic acid 55 mg/100g. The anthocyanin content of Jamun is 180.25mg/100ml. Turbidity of jamun juice was 136. The viscosity of jamun juice was found 12.2 cP.

The jamun fruit juice was obtained by boiling fruit in hot water, cooling, crushing with small amount of water and filtering the jamun pulp through double layer muslin cloth. The prepared jamun juice had purple colour, TSS of 13°Bx and pH of 3.6.

The jamun seed extract was prepared by the extracting the dried seed powder with use of ethanol in soxhlet apparatus and the yield was found to be 4.25 per cent.

In order to optimize the level of the jamun juice and water on the basis of sensory so as to make the product acceptable in terms of sensory characteristics. As the jamun juice without added water is very astringent to drink and hence 40 parts of water was added to the juice as suitable for the preparation of the jamun juice. This juice was most acceptable without addition of the any sweeteners. The level of alcoholic seed extract added to the juice on the basis of the effective doses of the seed extract in order to shows the anti-hyperglycemic

effect to consumer as the research done by the different scientists. Hence the seed extract added to the juice in the proportion of the 1.8 to 2.2 per cent.

Sample B having blending ratio of 60:2:38 was significantly superior in colour, flavor and taste over sample A and C. A good quality jamun juice with the seed extract of 2 per cent had acceptable colour, flavor and mouth feel and also showed from table that sample B having 2 per cent seed extract in jamun juice recorded highest score in all organoleptic attributes and found to be overall acceptable. The sample A also have good acceptability but as it is functional product it required higher dose of the seed extract hence we recommended the 2 per cent level of the juice with seed extract is the most desirable level. An increase in the concentration of the seed extract above 2 per cent level then decrease the acceptability as the seed extract may affect on the sensory characteristic of the product.

The jamun juice with added seed extract contains 12.8 per cent carbohydrate, 0.7 per cent of protein, 0.9 per cent of fiber and 0.1 per cent of fat. Proximate nutritional compositions among prepared jamun juice with seed extract was not much promising but this juice is having a great therapeutic value and nutritional value as an anti-diabetic juice.

The cost of production for 1 liter jamun juice enriched with seed extract is Rs 72.80 per liter of finished juice. The production of the jamun juice with the added seed extract is economically feasible and it can gives good profit to the producer. It has good medicinal value hence it can help to lower down the blood glucose level of the diabetic patients

The energy value of developed jamun juice enriched with jamun seed extract was found to be 54.9 K Cal/ 100 ml, which is quite lower than the marketed commercial fruit beverages. Thus this juice can help to the diabetic personals.

CONCLUSION

It can be concluded that jamun seed extract can be utilized successfully in preparation of jamun juice with seed extract. The seed extract had very good therapeutic value to control the blood glucose level. Thus the prepared product can be successfully useful to lower the blood glucose level of the diabetic personals. The prepared juice gives less than 54.9K Cal compared to available marketed commercial fruit drinks. The cost of production of the one liter jamun juice with the seed extract is 72.80 rupees which considerably lower than the available fruit drinks in the market.

Hence this developed technology of preparation of jamun juice enriched with seed extract can be explored commercially to prepare anti-diabetic product.

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Appendix – I

Organoleptic Evaluation score card

Date:

Name of Product:

Name of Evaluator:

Designation:

Sr. No.	Sample	Color and Appearance	Taste	Flavor	Texture	Overall acceptability
1						
2						
3						
4						

Hedonic Rating Scale
9 – Like extremely
8 – Like very much
7 – Like moderately
6 – Like slightly
5 – Neither like nor dislike
4 – Dislike slightly
3 – Dislike moderately
2 – Dislike very much
1 – Dislike extremely

Comment:

Signature of Evaluator