EFFECT OF SOME UNIT OPERATIONS ON QUALITY OF *KAJUKATLI*

A

THESIS

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BY

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ABSTRACT

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The *Kajukatli* is an indigenous sweet, prepared using principally cashewnut splits and sugar following traditional and manual methods. The preparation process involved grinding of soaked cashew nut splits, mixing with sugar, cooking, cooling, rolling and sheeting. From the preliminary study, it was observed that unit operations such as grinding and cooking play important role in deciding the product quality.

Experiments were designed and conducted to study the effect of grinding and cooking on sensory and textural attributes of *Kajukatli*. Followed by storage study at room (30±2˚C & 65% RH) and refrigerated (6±2˚C & 90% RH) conditions was conducted for the sample prepared at optimized/standardized process parameters and packed in commercially available PVC containers. The parameters considered were: water addition while grinding (20-32%), grinding time (6-12 min) and cooking temperature (70-100˚C). Factorial design was followed for these three variables at four levels to study the effect and optimization.

Kajukatli prepared with 28% water addition, grinding for 12 min and cooking at 100˚C temperature had highest overall acceptability (8.9). Hardness and yield point of the sample were 354.98 and 344.49 g, respectively. *Kajukatli* so prepared had shelf life of nine (9) days at room condition while it lasted for more than thirty (30) days in refrigerated condition with acceptable sensory, textural and microbial attributes.

Keywords: *Kajukatli*, Cashewnut splits, Particle size, Sensory, Texture, Microbial analysis, Storage

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LIST OF ABBREVIATIONS AND SYMBOLS

%	Percent
±	Plus or minus
µm	Micrometre
a_w	Water activity
ANOVA	Analysis of variance
$^{\circ}$B	brix
BT	Body & texture
^{0}C	Degree Celsius
CA	Color & appearance
cfu	colony forming unit
CKBB	cashew kernel baby bits
cm	centimetre
CNSL	Cashew nut shell liquid
C.D.	Critical difference
CT	Cooking temperature
C.V.	Coefficient of variation
db	Dry basis
D.F.	Degrees of freedom
F	Calculated F value
FL	Flavour
FMC	Final moisture content
g	gram (s)
GT	Grinding time
i.e.	That is
kg	kilogram (s)
kW	kilowatt
lit	litre (s)
mg	milligram (s)
min	minute (s)
H	Hardness
h	hour (s)
ml	millilitre (s)
OA	Overall acceptability

PDA	Potato dextrose agar
PVC	Polyvinyl chloride
ppm	parts per million
PS	Average Particle size
RH	Relative humidity
rpm	revolution per minute
SEm	standard error of mean
TPC	Total plate count
SS	Sum of Squares
t	Cooking time
WA	Water added while grinding
wb	Wet basis
WMP	Whole milk powder
YMC	Yeast & mold count
YP	Yield point

CHAPTER I

Introduction

Traditional products, such as *burfi, kalakand, peda, thabdi, halwasan, Kajukatli,* etc are not known only for their unique sensory attributes but also the traditional technology that has been associated with them. The products have very large consumer base both in India and abroad. The total Indian sweet market is estimated at $500m (Seth, 2010). If traditional sweets are proposed to be produced on commercial scales, it becomes imperative that suitable process technology be developed. Understanding the fundamental nature of these products in terms of chemical, microbiological, physical properties including texture and structure and effect of processing parameters have been considered to be the key to any technological advancement that can be made for the traditional products production on mass scale. So there is a continued interest in research on the traditional indigenous products.

Kajukatli is one of the nut based sweet manufactured and sold in large quantities in India and exported abroad. *Kajukatli's* main ingredient is Cashewnut (*Kaju*), kernel of evergreen tree *Anacardium occidentale. L.* grown in coastal areas of India. The country contributes over 43 % of world cashewnut production (Indurani *et al.*, 2007) and is consumed as whole, sugar or salt coated, paste or powdered form in a variety of Indian cuisine such as salads, curries and sweets like *Kaju burfi*, *Kaju halwa*, *Kaju chikki, Kaju kalinger* and *kajukatli* (Satyanarayan *et al.,* 1993). Cashewnut are of high nutritive value and contains about 21 percent of protein, fat (47%), moisture (5.9%), carbohydrates (22%), phosphorus (0.45%), calcium (0.05%), iron (5%) and other mineral elements (Anon, 2004).

Primary typical characteristics of *kajukatli* are: creamy white colour and characteristic flavor, smooth texture and usually diamond

shaped. The *Kajukatli* preparation process varies from halwais to organized sector. Parmar *et al.* (2013) has conducted survey in the city areas of Anand, Ahmedabad, Surat and Vadodara districts to study production equipments, practices and material used for preparation of *Kajukatli*. Cashewnut splits, locally known as *Kaju fada*, and sugar from local markets were used in all sites. Products were prepared manually either from 1) Cashewnut powder & sugar syrup or 2) Cashewnut paste & sugar. It was also observed that about 50-70% cashewnut splits, 30-50% sugar and 20-25% water were used for the preparation. Among the collected market and laboratory samples, product from cashewnut paste 65% and sugar 35% appreciated very well on different sensory characteristics (5% level of significance). Standardized process was wet grinding of soaked cashewnut splits, mixing with sugar, cooking the mixture at 85±5˚C for about 30 min followed by cooling to about 42˚C before spreading, rolling, sheeting and cutting. The product so prepared stored at room temperature in PVC container showed visible fungal growth after 10 days.

A number of variables influence the final product quality such as average particle size of ground cashewnut and moisture content before cooking, mixing with sugar, cooking temperature and time, cooking and cooling rate etc. From the preliminary trials, it was observed that unit operations such as grinding and cooking play important role in deciding the quality/desirability of the final product. A systematic study on the effect of grinding and cooking parameters would be useful for uniform quality production. Therefore, this research was envisaged considering the average particle size of the ground soaked cashewnut splits, which depend upon grinding time, moisture content and sample size, and cooking temperature and time need, to be study for the possible effect on product quality/desirability and storability. The present study was planned with the following objectives:

Objectives

1. To optimize grinding and cooking parameters for production of superior quality of *Kajukatli.*
2. To study the shelf life of *Kajukatli* made under optimized condition.

CHAPTER II

Review of literature

Traditional Indian milk products and sweets have been an inseparable part of the socio – cultural life of India. Getting a job, inauguration of new house, feasts, festivals, social or religious occasions; milk sweets are always offered **(Bandyopadhyay et al., 2006)**. In the context of present policy of globalization, the business leaders of the multinationals are trying to explore the vast unexplored areas of Indian traditional sweet food products inherited from the Indian heritage and culture since the vedic times. Tremendous scope exists if we employ our own traditional wealth of knowledge in science and technology blended with the art and literature of our people.

At present in India more than 150 types of sweetmeats are available. Among them *peda*, *burfi* and *kalakand* are dominating the market. *Kajukatli*, *Kajukatri* or *Kaju Burfi* is the product that resembles to *burfi* in many aspects. *Kajukatli* is a popular sweet mainly manufactured in west Bengal. There are other region specific sweets which are also very popular but not well characterized. The literature available is very meager. However the review of literature pertaining to different aspects is as under

2.1 Cashew nut (*Kaju*)

Cashew nut is often referred to as 'wonder nut', is one of the most valuable processed nuts traded on the global commodity markets and is also an important cash crop.

Cashew tree is believed to be a native of Brazil, from where it has dispersed to different parts of the world primarily for soil conservation, afforestation and wasteland development. The term 'Cashew' has originated from the Brazilian name 'acajaiba' and the

Tupi name 'acaju', which the Portuguese converted into 'caju' and is commonly known as 'kaju' in India.

Cashew is mainly cultivated in Asia, Africa and Latin America. India is the largest producer of cashew nut in the world as well as in Asia accounting 39.47% of world cashew production in 2010. As per the F.A.O statistics, 21.6% of the world harvested area under cashew nut was in India and the country accounted for 17.3% of the total world cashewnut production during the year 2009-10 **(Senthil and Mahesh, 2013)**.

Country-wise analysis of area harvested under cashew indicates that although the share of India has declined from 38.72% in 1961 to 21.6% in 2007, India continues to have the maximum area (8.54 lakh ha) under cashew in the world followed by Brazil (18.5%) and Côte d'Ivoire (16.7%) in 2007. As per FAO statistics, Vietnam topped global production with 12.07 lakh tonnes, followed by Nigeria (6.60 lakh tonnes), India (6.20 lakh tonnes), Côte d'Ivoire (2.80 lakh tonnes), Indonesia (1.46 lakh tonnes) and Brazil (1.40 lakh tonnes) during 2007. However, in terms of area, Vietnam was at the sixth position. The yield per hectare in India was 860 kg during 2007-08 as compared to 4125 kg/ha in Vietnam and 2000 kg/ha in Nigeria **(Yadav, 2010)**. Major reasons attributing to low productivity in the country were sizeable area under cashew in the country being covered with seedling progenies, planting of cashew in marginal and poor fertile land, non adoption of recommended package of practices and pest infestation (tea mosquito bug and cashew stem and root borer). In India, cultivation of cashew is confined to Kerala, Karnataka, Goa and Maharashtra along the west coast and Tamil Nadu, Andhra Pradesh, Orissa and West Bengal along the east coast **(Kulkarni et al., 2012)**.

The domestic cashew processing industry had a total capacity to process an estimated 15 lakh tonnes per annum against the domestic

production of 5.73 lakh tonnes of raw nuts (2005-06), pointing to the wide gap between demand and domestic supply. The share of imported nuts in the total volume of raw nuts processed has increased from 34.7% during 1995-96 to 47.68% during 2007-08. India contributes over 43% of world cashew nut production **(Indurani *et al.*, 2007)** and is used in whole, paste or powdered form in variety of Indian cuisine such as salads, curries and sweets.

A variety of products can get from cashewnut i.e., roasted or salted cashew nut, cashew nut flour, cashew kernel oil, cashew nut shell liquid, cashew kernel baby bits etc. Cashewnut based sweets like cashew nut *burfi*, chikki, and halwa are also popular throughout India. Despite of its high costs, cashew nut products are in demand. *Kajukatli* is one of the most popular cashewnut based sweets. It is popular all over the India because of its delicate texture, good flavor and excellent mouth feel. Few reports are available on cashewnut products preparation. Therefore an attempt is made here to review the methods of preparation and characteristics of *Kajukatli* and similar products i.e. *burfi* etc. But there is not a single scientific study conducted and reported. Because of this lacuna, an attempt is made here to review the methods of preparations of *Kajukatli* manufactured by various dairy industry and *halwais* and to some extent *burfi* particularly their characteristics and market qualities.

2.2 Cashew Nut's products

Mahesh and Nagaraja (2002) studied that value addition in cashew is one of the emerging areas. Earlier, attempts have been made for coating of cashew kernels with salt **(Jasper, 1970; Prasad, 1954; Prasad *et al.* 1955)** and preparation of *burfi* **(Satyanarayan *et al.*, 1993)**. Value addition of cashew (*Anacardium occidentale* L.) kernel baby bits (CKBB) has been attempted by coating with cane sugar, honey and salt. Optimum coating occurs at 100°C for 5 min at 70%

concentration for cane sugar and honey and 5% for salt. Sweetened (70%) and vanillin (0.1%) flavored CKBB are the most preferred. Cashew apple juice could be coated on the CKBB. Acceptability of cashew apple juice coated baby bits (BB) improves with the addition of cane sugar at 70% concentration.

Nagaraja (2003) examined that the processing is required to get edible kernels from cashew (*Anacardium occidentale*). Commercial processing of cashew involves number of steps such as roasting, shelling, peeling, grading and packing. Different grades of kernels such as wholes, splits, bits, etc. are obtained during commercial processing. Cashew kernel baby bits (CKBB) are the lowest grade kernels obtained and is sold at Rs. 120/kg in the market. Sweetened and flavored spread has been prepared from cashew kernel baby bits (CKBB). Among the sweetened spreads prepared with different flavors, cardamom flavored spread was the most preferred. Defatting of CKBB did not affect the organoleptic acceptability of the spread. Mixing of groundnut kernels in equal proportion did not affect the organoleptic acceptability of the spread.

Akinhanmi *et al.* **(2008)** studied that cashew nut yields two "Oils" one of these found, between the seed coat (or pericarp) and the nuts, is called the Cashew Nut Shell Liquid (CNSL). It is not a triglyceride and contains a high proportion of phenolic compound. It is used in industry as a raw material for brake lining compounds, as a water proofing agent, a preservative and in the manufacturing of paints and plastics. Cashew apples are sometimes made locally into fruit drinks, wines and pickles.

2.3 Commercial production of *Kajukatli*

Parmar (2012) studied the commercial product practices in the city areas of Anand, Ahmedabad, Surat and Vadodara districts. The samples from the sites/commercial counters were collected for the

study. Product prepared from cashew nut paste was observed best among the samples. Recipe and method of preparation was standardized based on higher sensory and acceptable textural attributes. Standardized process for preparation of *Kajukatli* was: cashew nut paste was prepared from cashew nut splits, after soaking in twice quantity of water at room temperature for about 1 h. 65% of cashew nut paste was then mix with 35% sugar powder manually and cooked at 80-90°C, for about 30-35 min followed by cooling, spreading, rolling, sheeting and cutting.

Macwan (2012) standardized the process of *Kajukatli* by incorporating milk solids. Standardized process for preparation of *Khoa* based *Kajukatli* was: Preparation of syrup (70°B) using sugar at the rate of 50% of cashew-*khoa* blend. Cashew nut powder was then mixed with syrup and cooked at 85°C. *Khoa* was added after 5 min of cooking and the mixture was then transferred to wooden flat surface, once mass starts leaving the surface of the vessel followed by cooling, spreading, rolling, sheeting and cutting.

Bandhopadhayay *et al.* **(2006)** described technique for preparation of *Kajukatli* by using cashew nut paste was blended with sugar, heated at 85˚C for 20 minutes, followed by cooling down to room temperature in 20 min, rolled out on a flat surface, covered with silver foil and cut into diamond shapes. Continuous stirring during mixing of cashewnut paste and sugar was given as the major factor affecting the product quality.

Satyanarayana *et al.* **(1993)** has investigated several recipes containing different quantities of cashewnuts, sugar, WMP and vanaspati fat/oil and standardized the method for cashwnut *burfi*. The standardized cashewnut *burfi* with a composition of cashewnut 22.1 parts, sugar 44.2parts, WMP 11.05parts, vanaspati fat/oil 11.05 parts, cardamom powder 0.55parts and water 11.05parts.

2.4 Storage study

Parmar (2012) has reported fungal growth (mucor) in the sample after 10 days of storage at room temperature whereas no such visible spoilage was observed in refrigerated condition.

Shelf life of standardized *khoa* based *Kajukatli* was reported by **Macwan (2012)** as 2 days when stored at room temperature (30±2˚C) and more than 28 days at refrigeration temperature (7±2˚C).

Bandhopadhayay *et al.* **(2006)** reported the shelflife of *Kaju burfi,* prepared using paste method as 2-5 days at ambient conditions.

Ghodekar (1969) found that burfi stored at 37˚C storage condition had total bacterial count ranging from $50x10^2$-$11\ x10^2$ cfu/g, yeast count $4x10^1$-$65x10^2$ cfu/g, mold count $2x10^1$- $30x10^4$ cfu/g. Shelf life of *burfi* samples stored at 30 and 37˚C were found to be 14 days and 30 days under refrigerated condition.

Ramanna *et al.* (1983) enhanced the shelf life of *burfi* up to 90 days by incorporating 0.15% sorbic acid and packing it in an polycel inserted in a polyethylene pouch.

Sachdeva and Rajhoria (1982) studied the chemical and microbiological changes in plain *burfi* during storage at 30˚C and 5˚C. The *burfi* samples were studied after packaging in parchment paper upto 50 days while in tin it was stored up to 65 days. The microbiological attributes were monitored for SPC count per g of the samples packed using both of the packages. It increased significantly from the initial value of $200x10^3$ to $1120x10^3$ and $250x10^3$ to $1000x10^3$ for both the packages. The yeast and mold were not found in any of the samples packed using both of the packages upto 15 days of storage which were traced after 25 days and thereafter they increased linearly from 50 to 220 and 90 to 470 respectively for parchment paper and tin packed products. *Burfi* packed in tins and

stored at 5±1 ˚C remained good for more than 150 days and its shelf life was predicted to be 6 months.

Makhecha (2012) studied the shelf life of *thabdi* employing different packaging material. *Thabdi* is a heat desiccated milk based sweet having yellowish-brown to brown colour, firm to lightly loose grainy texture having small pools of melted fat smear of solidified fat on the surface and cooked, rich nutty, ghee like flavor. Different packaging material such as (i) Polyester /al-foil/polyfilm PE pouches (64 µ) (ii) Met-Polyester/Polyfilm PE pouches (106µ) (iii) polyester/Polyfilm pouches (74 µ) (iv) polyester/Nylon/Retort CPP pouches (108 µ) (v) PE Box and (vi) Laminated cardboard box were studied for *thabdi*. The *thabdi* sample remained acceptable in all of the packages up to 10 days and 56 days when stored at room and refrigeration temperature respectively. The Polyester/Al-foil/polyfilm PE pouches packaging material was reported to be the best.

Rao and Goyal (2007) studied the effect of packaging and storage on the sensory quality of *Kalakand*. The sensory evaluation of *Kalakand* samples stored in five different packages at 30±1˚C, 65% RH and 6±1˚C at 90% RH for various time intervals. They found that both individually, have significant effects on the sensory scores of K*alakand* under both condition of storage.

Satyanarayana *et* al. (1993) reported preservation of cashew nut *burfi* with preservatives like butylated hydroxyl anisole and sorbic acid. The *burfi* had shelflife of 3 months at 37˚C and 6 months at ambient temperature (19-27˚C) when packed in polypropylene and paper-aluminium foil-polyethylene laminate pouches.

Date and Bhatia (1955) found that *burfi* samples with moisture content ranging from 5.0-9.0 % could be stored for 6 months. Such low moisture content in *burfi* would however render the product hard and dry.

CHAPTER III

Materials and Methods

The preparation of *Kajukatli* varies place-to-place and person-to-person. In general, it is prepared by mixing of *Kaju* or Cashew (*Anacardium occidentale L.*) nut, with sugar or sugar syrup, cooking, cooling, rolling, sheeting and cutting. Silver foils may also be applied after sheeting and before cutting. **Parmar (2012)** conducted survey in the city areas of Anand, Ahmedabad, Surat and Vadodara (Baroda) district, to study *Kajukatli* preparation practices. Based on sensory study, recipe and preparation process was standardized for *Kajukatli*. The standardized flow chart for the process is shown in Fig. 3.1. The parameters affecting various unit operations and product quality are also given there in.

Since the textural and sensory attributes would be influenced by several parameters involved at various stages as shown in Fig. 3.1, it was desirable to keep some parameters fixed and some variable. The values of fixed parameters were determined by trial runs or literature search. The details of raw material, fixed and variable parameters, experimental plan, experimental procedure and determination of different responses follow.

3.1 Materials

3.1.1 Cashewnut (*Kaju*)

Cashewnut splits, locally known as *kaju fada,* off white in color, without stalks, free from rancid off flavour was procured from sardarganj local market, Anand, Gujarat. The splits were stored in plastic bags (Plate 3.1) at room temperature. The composition of cashewnut used was analysed and given in the following Table 3.1.

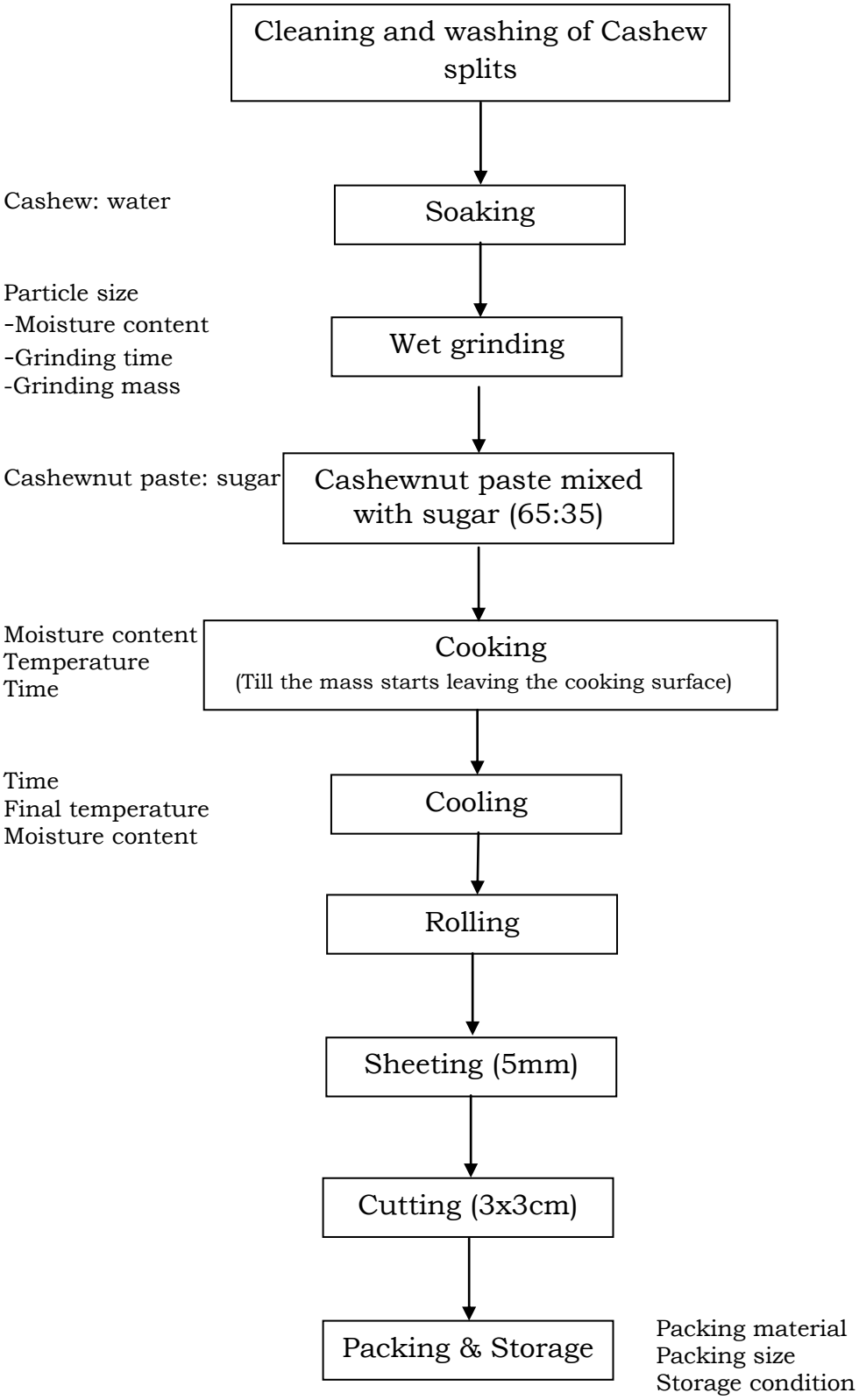


Fig. 3.1 Standardized flowchart of preparation of *Kajukatli* (Parmar,2012).

Table 3.1: Composition of cashewnut used for *Kajukatli*

Parameters	**Percent**
Moisture	9.87 ± 0.08
Fat	43.58 ± 2.37
Protein	20.6 ± 1.02
Carbohydrate	25.68 ± 0.06
Ash	2.7 ± 0.05

Plate 3.1 Cashewnut splits used for *Kajukatli* preperation

3.1.2 Sugar

Local available refined sugar (~0.50 mm), free from dirt, was procured from sardarganj, Anand, Gujarat and stored in moisture tight plastic bags.

3.2 Selection of fixed parameter values

Some preliminary trials/studies were conducted in order to fix certain parameters affecting the product quality. The parameters considered in the preliminary study were related to soaking, grinding and cooling.

3.2.1 Standardization of soaking condition

Cashewnut splits was cleaned and washed twice and soaked in twice quantity of water at room temperature. Approximately 20-33% of weight gain was observed after soaking for 1 h and more. RO water was used for washing and cleaning.

3.2.2 Sample size during grinding

Considering the maximum grinding volume 1000 ml of laboratory grinder (Make: Sumeet, 4 blades & 400 watts), trials were conducted at 125, 250 and 375 g sample of soaked cashewnut without addition of water. At 125 g requires addition of water and/or frequent handling/ levelling of the grinding mass, while sample size of 375 g overloads the grinder. Therefore, 250 g sample size was selected for the study. However, addition of water eased the grinding and therefore, amount of water added selected as variable.

3.2.3 Standardization of cooling condition

Commercial practices for *Kajukatli* preparation involves cooking of Cashewnut paste-sugar mixture followed by cooling the cooked mixture to 40-45˚C and rolling on flat surface **(Parmar, 2012)**. During preliminary trials, cooked mass (~430 g) was transferred to another vessel for cooling. Continuous stirring for about 9-10 min was required to attain 40-45˚C temperature. It was observed that if the

mix cooled below 40˚C rolling, sheeting and cutting were difficult, and if the temperature of mix is more than 45˚C spreading and rolling were difficult due to its stickiness. It was also observed that texture of the final product depends on the cooling temperature and rate. There, for each experiment, mass was cooled to ~42˚C with continuous stirring.

3.3 Variable parameters

This part involves selection of the amount of water added while grinding, time of grinding and the cooking temperature for *Kajukatli* preparation. The samples were evaluated for sensory and textural attributes. The standardized sample was subjected to physicochemical, microbial, textural and sensory characteristics analysis.

3.3.1 Water added during grinding

Parmar (2012) reported that during grinding, at commercial level addition of water reduces grinding time and produce almost uniform particle size smooth paste. 250 g soaked cashewnut splits was ground for 1 min. and water was added in the range of 20-32 % of weight of soaked cashewnut splits. The mixture was again ground for uniform consistency and time of grinding was observed. It was found that water addition below 20% resulted non uniform ground paste and maximum grinding time was observed as 12 min. Water addition from 20-32 % was selected for the study.

3.3.2 Grinding time

During preliminary trials, it was observed that the paste with less water added requires higher grinding time of about 10-12 min. The paste with about 30-32% extra water requires 6 min. grinding time for similar paste consistency. Therefore, to study the grinding time effect, grinding period of 6-12 min. was selected.

3.3.3 Cooking temperature

In commercial practices, Steam jacketed kettle or thick sheet *Karahi* were used for cooking. Cooking is carried out at 80-85˚C for 30-35 min with continuous manual scraping until it starts leaving the surface of the cooking kettle or *Karahi*. Since, the cooking temperature has an effect on time required for cooking and textural properties of *Kajukatli,* the mixture was cooked at variable temperatures and required cooking time was noted. For experiments, a self made cooking assembly consisting of water bath, thick bottom S.S. top and manual scraper was used (Fig. 3.2). The maximum temperature achievable by the water bath was 100˚C. Therefore, temperature level of 70, 80, 90 & 100°C was selected to study the effect.

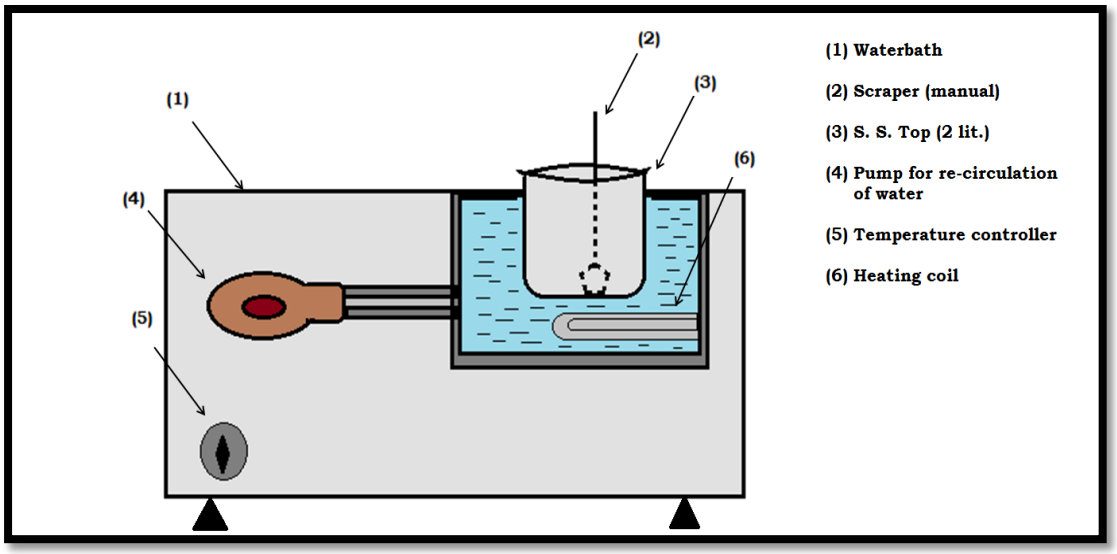


Fig. 3.2: Schematic diagram of cooking assembly

3.4 Experimental design

Factorial design was used to study the effect of three variables at four levels. Minitab (version: 15.1.30.0) & Design Expert (version: 8.7.0.1) were used for analyzing and standardizing/optimizing the variables for acceptable level of responses of multivariate system. Table3.2 shows the experimental run and combinations.

3.5 Experimental plan

Based on design, all the experiments were carried out as per the steps given in Fig. 3.2.

Table 3.2 Experimental combinations for *Kajukatli* preparation

Treatments	Water added for grinding	Grinding time	Cooking temperature
	% of wt. of soaked cashewnut splits	min	˚C
T_1	20	6	70
T_2	24	6	70
T_3	28	6	70
T_4	32	6	70
T_5	20	8	70
T_6	24	8	70
T_7	28	8	70
T_8	32	8	70
T_9	20	10	70
T_{10}	24	10	70
T_{11}	28	10	70
T_{12}	32	10	70
T_{13}	20	12	70
T_{14}	24	12	70
T_{15}	28	12	70
T_{16}	32	12	70
T_{17}	20	6	80
T_{18}	24	6	80
T_{19}	28	6	80
T_{20}	32	6	80
T_{21}	20	8	80
T_{22}	24	8	80
T_{23}	28	8	80
T_{24}	32	8	80
T_{25}	20	10	80
T_{26}	24	10	80
T_{27}	28	10	80
T_{28}	32	10	80
T_{29}	20	12	80
T_{30}	24	12	80
T_{31}	28	12	80
T_{32}	32	12	80
T_{33}	20	6	90
T_{34}	24	6	90

T_{35}	28	6	90
T_{36}	32	6	90
T_{37}	20	8	90
T_{38}	24	8	90
T_{39}	28	8	90
T_{40}	32	8	90
T_{41}	20	10	90
T_{42}	24	10	90
T_{43}	28	10	90
T_{44}	32	10	90
T_{45}	20	12	90
T_{46}	24	12	90
T_{47}	28	12	90
T_{48}	32	12	90
T_{49}	20	6	100
T_{50}	24	6	100
T_{51}	28	6	100
T_{52}	32	6	100
T_{53}	20	8	100
T_{54}	24	8	100
T_{55}	28	8	100
T_{56}	32	8	100
T_{57}	20	10	100
T_{58}	24	10	100
T_{59}	28	10	100
T_{60}	32	10	100
T_{61}	20	12	100
T_{62}	24	12	100
T_{63}	28	12	100
T_{64}	32	12	100

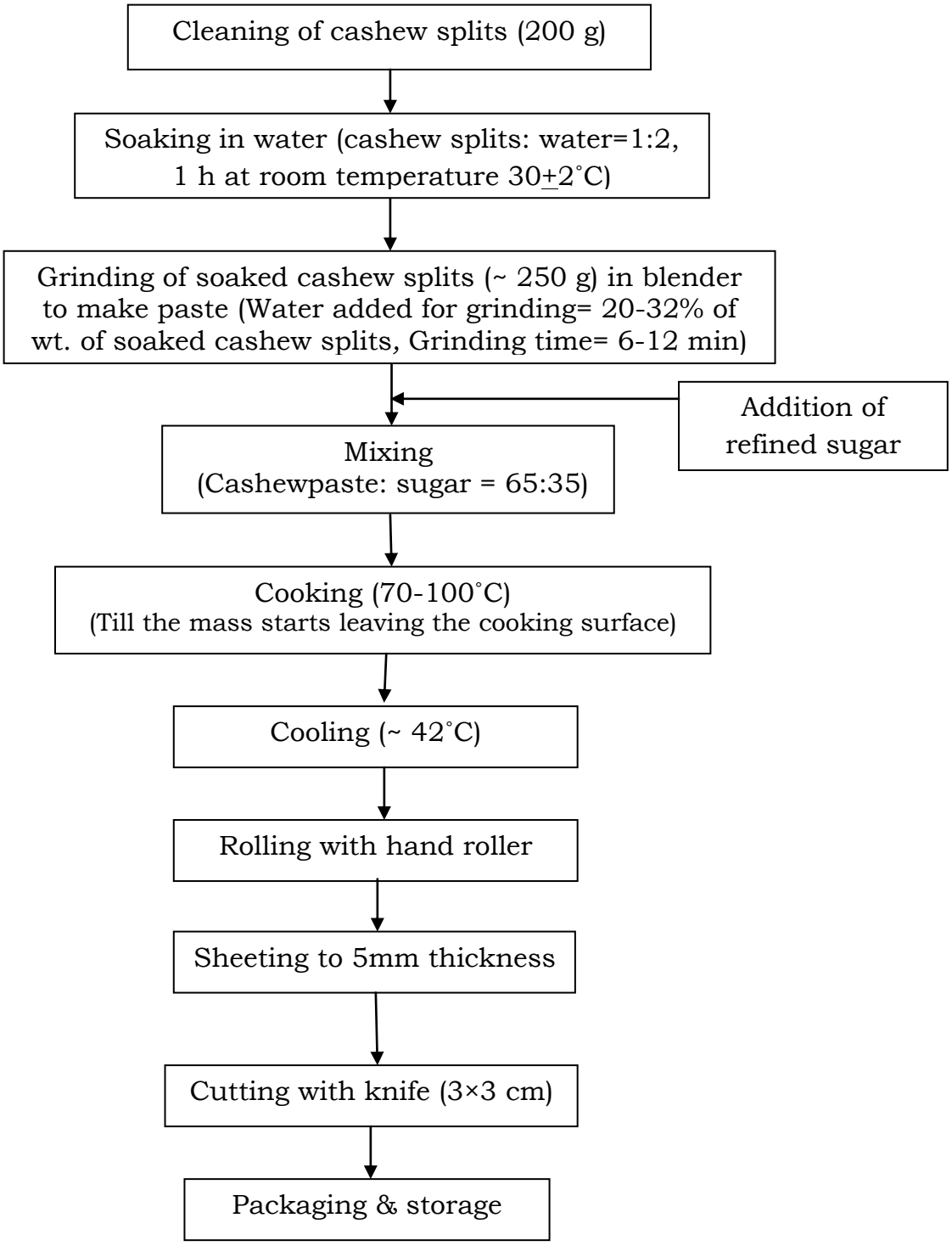


Fig. 3.3 Schematic plan of work for study

3.6 Experimental procedure

Kajukatli preparation involves preparation of cashewnut splits by cleaning, washing and soaking. soaked cashewnut splits was ground, mixed with sugar, cooking, rolling, sheeting & cutting in diamond shaped pieces.

Soaked cashewnut splits 250 g was ground for 1 min using mixture grinder (Make: Sumeet, 4 blades & 400 watts), then water was added with desired level 20, 24, 28 & 32% weight of soaked cashewnut splits. The mass was then further ground for total desired grinding period of 6, 8, 10 & 12 min. After that the cashewnut paste was transferred into thick bottom S.S. top and sugar was added and mixed manually with help of scraper. The S.S. top was then placed in water bath maintained at desired cooking temperature of 70, 80, 90 & 100°C. The mixture was stirred manually with help of scraper until it starts leaving the surface of the vessel. The cooked mixture was then cooled in another vessel up to 42°C, rolled using hand roller (*bellan*) to the thickness of 5 mm and cut by knife in the size of 3 cm ×3 cm. Preparation steps with fixed and varied variable ranges are shown in the Fig 3.2. The Kajukatli so prepared was evaluated for sensory and textural characteristics. Based on overall acceptability of sensory evaluation and textural characteristics, amount of water added for grinding, time of grinding and the cooking temperature were selected for further study.

3.7 Methods of analysis

3.7.1 Moisture content

Moisture content of *Kajukatli* was determined by hot air oven method (AOAC, 1995) at various stages of experiments. Moisture dish was cleaned and dried at 105°C in hot air oven (Make: NOVA, 1.5 kW) in triplicate, each for 2 h and then cooled in a desiccators. The *Kajukatli* samples weighing 5 g were taken into the moisture dish and dried at 105°C for 4 h until the weight was constant. The moisture dish containing sample was cooled in desiccators. A weighing balance

(WENSAR, PMB200) of 200 g capacity with a least count of 0.001 g was used for weighing. The percentage moisture content was calculated using following expressions.

$$Moistture\ content\ (\%)db = \frac{W_2 - W_3}{W_3 - W_1}\ X\ 100$$

$$Moistture\ content\ (\%)wb = \frac{W_2 - W_3}{W_2 - W_1}\ X\ 100$$

Where,

W_1= Initial weight of moisture dish (g)

W_2= Weight of moisture dish containing sample before drying (g)

W_3= Weight of moisture dish containing sample after drying (g)

3.7.2 Water activity

The concept of water activity has a particular importance as an indicator of product quality, safety and storability. The water activity of *Kajukatli* samples, tempered at 25°C temperature, was measured using *Novasina water activity meter* with a measuring range of 0-100% relative humidity (RH).

The sample of *Kajukatli* was filled in a dish up to the brim to the maximum possible extent and the dish was kept in an air tight chamber taking care that the sample does not touch the diaphragm of the sensor. The chamber was then closed in a manner so as to ensure metallic contact between the two parts. The water activity of the *Kajukatli* sample was recorded with respect to atmospheric temperature (32°C as reference temperature).

3.7.3 Particle size analysis

Particle size of cashewnut paste samples were analyzed in triplicates. An Automated particle size analysis system (Biovis Particle Size Analyser, Motic DMB1) was used for the determination of particle size of cashewnut paste. Approximately 2-3 g of sample were spread on glass slide to make thin layer and placed below the miniature to capture images. The captured image was analyzed using Biovis Image

plus software (V4.56). Average of observed particle sizes (µm) was reported considering consolidated report of three images of a batch.

3.7.4 Sensory evaluation

For the sensory evaluation of *Kajukatli*, the samples were evaluated using a 9 point hedonic rating test. A sensory judging panel was constituted with panelists among the faculty members and students of the institute. The panelists were instructed to rate each sample on 9 point hedonic scale which included score for color and appearance, body and texture, flavor, taste and overall acceptability. The judges were also requested to give comments for each attributed of the samples. The final score for each attribute was obtained by averaging the score of all the panelists.

3.7.5 Texture Profile Analysis

Texture profile analysis of three samples from each experiment was done on TA-HDi Texture analyzer (Stable micro systems, UK) fitted with 5kg load cell. Both properties of the product were measured with the help of Warner Bratzler blade probe (HDP/BS).

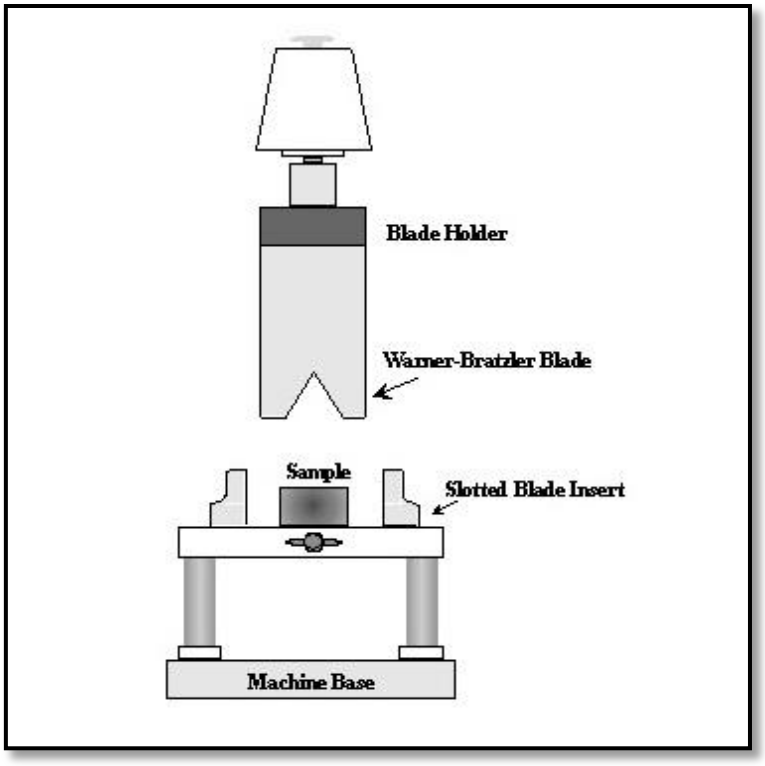
The texture analysis parameters were:

Pre test speed= 7mm/s, Test speed= 1mm/s, Post test speed= 10mm/s and distance=35 mm

The test was run by using Texture Expert Exceed software version 2.64 after setting all the parameters as given above. *Kajukatli* samples in triplicate were tested for hardness and yield point and average values were used in the analysis. Hardness and yield point were calculated by analysis of Texture Profile Analysis (TPA) graph.

Wherein, hardness is defined as the maximum peak force during the first compression cycle. Higher value is indicative of greater hardness value. Yield point is defined as the point where the force deformation curve starts to level off. The increase in force is not proportional to the increase in deformation **(Christensen**, **2012)**.

Fig. 3.4 Texture Expert Exceed with Warner Bratzler blade probe (HDP/BS)



3.7.6 Microbiological analysis

The samples of *Kajukatli* were subjected to microbial analysis for standard plate count (SPC) using nutrient agar, coliform count using Macconkey agar and yeast and mould count using freshly prepared acidified (pH adjusted to 3.5 by sterile 10 per cent tartaric acid solution) potato dextrose agar, as per the standard procedure **(Ranganna, 1986)**.

3.7.6.1 Preparation of dilutions

Kajukatli sample of 11 g was aseptically weighed and transferred to the bag filter containing 99 ml of sterile citrate buffer to obtain 1:10 dilution. Subsequently 1 ml of above dilution was used for making further dilutions in 9 ml sterile distilled water tubes. Suitable dilutions were prepared and poured in a set of sterile petri plates in duplicates.

3.7.6.2 Standard Plate Count

From the suitable dilution 1 ml of each sample prepared was used for plating in duplicates as described by **Ranganna (1986)**, and thereafter 15-20 ml of molten Nutrient agar was poured aseptically to plates. The contents were mixed and plates were cooled. The plates then were inverted and incubated in an incubator maintained at 37±0.5˚C for 24 h and number of colony forming units (cfu/ml) was noted.

3.7.6.3 Coliform count

The method for preparation of dilutions was mentioned above in 3.7.6.1. As described by **Ranganna (1986)** 1 ml of suitable dilution from each sample prepared was used for plating in duplicates. After pouring the melted (~20 ml) Macconkey agar to each petri plates, the contents were mixed and agar was allowed to solidify. Again 5 ml of additional layer of Macconkey agar was poured over the solidified later to have a second layer. The plates were inverted and incubated at

37±0.5˚C for 48 h and numbers of colony forming unit (cfu/ml) were recorded.

3.7.6.4 Yeast and mould count

The method preparation of dilutions was mentioned above in section 3.7.6.1. As described by **Ranganna (1986)** from each sample 1 ml of suitable dilution prepared was used for plating in duplicates, and thereafter 15-20 ml of molten PDA was poured aseptically to plates. The contents were mixed and plates were cooled. The plates were inverted and incubated at 25±0.5˚C for 3 days and numbers of colony forming unit (cfu/ml) were noted.

3.8 Storage Study

Standardized sample of *Kajukatli* were kept in the desiccators. Potassium Iodide and Potassium chloride **(Greenspan, 1976)** saturated salt solutions were used to maintain the relative humidity at 65% approx at a 30±2°C temperature and 90% approx at a 6 ±2°C, respectively. Prepared *Kajukatli* (~250 g) were packed in commercially available PVC container and kept in the desiccators for the study. The desiccators were placed inside temperature-controlled chamber at room temperature (30±2˚C, 65% RH) and were drawn from PVC container under laminar flow chamber at an interval of 3 days. Whereas, samples stored at (6 ±2˚C, 90% RH) was drawn at an interval of 6 days for analysis. Moisture content, water activity, textural attributes and sensory attributes of each sample were analyzed.

CHAPTER IV

Results and Discussion

The *Kajukatli* preparation follows traditional and manual methods. Parmar (2012) standardized the recipe and preparation process based on market survey and sensory analysis. Preparation process involves grinding of soaked cashew nut splits, mixing with sugar, cooking, cooling, rolling and sheeting. From the preliminary trials, it was observed that unit operations such as grinding and cooking play very important role in deciding the product quality. Designed experiments were conducted to study the effect of grinding and cooking on sensory and textural attributes of *Kajukatli*. The parameters considered were: water addition (WA) while grinding (20-32%), grinding time (6-12 min) and cooking temperature (70-100 ˚C). Factorial design was followed for these three variables at four levels.

The score of sensory attributes: colour and appearance (CA), flavor (FL), body and texture (BT) and overall acceptability (OA); average particle size (PS) of ground cashew nut splits in μm, cooking time (t) in min and final moisture content (MC) of *Kajukatli* in % d.b. and textural attributes: hardness (H) and yield point (YP) in g were measured for different experimental combinations. The results of different processing parameters combinations shown in Table 4.1 and storage study of the product (Plate 4.1) at standardized condition are discussed below.

4.1 Effects of unit operations on *Kajukatli* quality and preparation

Cooking period for Kajukatli preparations was measured as the mass started leaving the cooking surface and the time varied from 32-60 min. As expected, lower time was observed at higher temperature and higher time at lower temperature. The effects of all variables were not significant. However, variables were having significant total effect on almost all sensory and textural attributes (Table 4.2).

Table 4.1: Response values for the *Kajukatli* preparations

Run	Factors			Responses								
	WA (%)	**Gt (min)**	**CT (^{0}C)**	**PS (µm)**	**MC (% d.b.)**	**CA**	**BT**	**FL**	**OA**	**H (g)**	**YP (g)**	**t (min)**
T1	20	6	70	9.7	11.15	7.3	7.2	8.3	7.6	145.49	141.63	45
T2	24	6	70	9.5	10.10	7.4	7.7	8.1	7.7	254.36	189.45	52
T3	28	6	70	9.1	11.34	8.0	7.0	8.0	7.7	241.00	209.77	60
T4	32	6	70	7.9	10.32	7.9	8.2	8.3	8.1	328.79	205.70	70
T5	20	8	70	7.2	11.86	7.5	7.2	8.4	7.7	159.13	154.31	45
T6	24	8	70	7.9	10.34	7.9	7.4	8.2	7.8	305.46	246.32	52
T7	28	8	70	5.8	11.49	8.1	7.9	8.3	8.1	347.05	222.00	60
T8	32	8	70	6.4	11.37	8.1	8.0	8.3	8.1	193.06	149.48	70
T9	20	10	70	5.5	11.23	7.8	7.6	8.5	8.0	243.28	157.05	45
T10	24	10	70	6.5	12.02	7.9	7.9	8.4	8.1	281.95	274.31	52
T11	28	10	70	3.5	9.41	7.9	7.8	8.3	8.0	219.75	210.77	60
T12	32	10	70	3.2	13.49	8.2	8.1	8.4	8.2	219.75	196.11	70
T13	20	12	70	3.8	11.48	8.5	7.8	8.2	8.2	142.45	138.67	45
T14	24	12	70	2.3	10.00	8.0	7.2	8.1	7.8	210.69	203.70	52
T15	28	12	70	3.2	9.30	8.6	8.2	8.6	8.5	251.03	209.77	60
T16	32	12	70	4.3	10.34	8.8	8.3	8.8	8.6	205.70	194.78	70
T17	20	6	80	12.9	9.96	7.9	7.7	8.5	8.0	194.39	183.70	40
T18	24	6	80	9.5	9.93	8.0	7.4	8.4	7.9	256.71	197.29	47
T19	28	6	80	8.8	10.72	7.6	7.4	8.6	7.9	282.02	216.78	52
T20	32	6	80	6.4	12.95	8.4	7.8	8.5	8.2	356.95	278.80	60
T21	20	8	80	6.7	11.52	8.0	8.0	8.3	8.1	257.80	166.10	40
T22	24	8	80	8.8	13.23	8.0	8.2	8.4	8.2	313.98	249.48	47
T23	28	8	80	6.9	10.73	8.4	8.1	8.5	8.3	354.98	245.65	52
T24	32	8	80	4.9	9.26	8.4	8.0	8.4	8.3	294.80	272.42	60
T25	20	10	80	5.5	11.66	8.0	7.7	8.6	8.1	266.77	237.60	40
T26	24	10	80	6.9	12.72	8.1	7.6	8.5	8.1	286.46	265.26	47
T27	28	10	80	3.8	12.29	8.6	7.6	8.6	8.3	230.71	226.30	52
T28	32	10	80	3.9	11.48	8.6	7.9	8.6	8.4	293.79	260.67	60
T29	20	12	80	3.3	11.62	8.5	7.9	8.5	8.3	198.15	187.45	40
T30	24	12	80	3.5	17.88	8.0	7.0	8.6	7.9	260.18	252.77	47
T31	28	12	80	3.5	8.58	8.6	8.4	8.6	8.5	284.88	261.32	52
T32	32	12	80	3.8	10.07	8.7	8.3	8.7	8.6	284.34	257.45	60
T33	20	6	90	9.7	13.18	8.2	7.4	8.7	8.1	496.53	198.67	35
T34	24	6	90	8.6	11.24	7.7	7.8	8.8	8.1	468.00	270.29	40
T35	28	6	90	9.9	12.09	8.5	7.9	8.5	8.3	499.47	280.88	45
T36	32	6	90	7.9	11.51	8.2	7.9	8.7	8.3	435.76	357.45	48

T37	20	8	90	7.9	14.49	8.5	7.9	8.6	8.3	285.25	183.50	35
T38	24	8	90	8.5	10.66	8.5	7.4	8.5	8.1	392.64	256.31	40
T39	28	8	90	7.5	10.06	8.1	8.3	8.8	8.4	381.38	261.51	45
T40	32	8	90	7.5	10.54	8.6	8.3	8.7	8.5	295.52	262.42	48
T41	20	10	90	6.5	11.51	8.6	8.5	8.6	8.6	278.85	256.30	35
T42	24	10	90	6.9	10.53	7.8	8.3	8.6	8.3	354.69	330.68	40
T43	28	10	90	3.6	11.99	8.4	8.7	8.8	8.6	288.39	274.57	45
T44	32	10	90	2.9	10.15	8.6	8.7	9.0	8.7	311.69	283.20	48
T45	20	12	90	2.5	9.90	8.9	7.7	8.9	8.5	217.80	209.30	35
T46	24	12	90	2.8	10.68	8.5	8.5	8.6	8.5	287.71	284.14	40
T47	28	12	90	2.7	13.29	9.0	8.6	8.5	8.7	306.80	297.12	45
T48	32	12	90	2.6	12.44	8.6	7.7	8.6	8.3	381.33	367.23	48
T49	20	6	100	7.8	11.39	7.9	7.8	8.6	8.1	538.20	219.78	32
T50	24	6	100	7.3	12.48	7.7	7.4	8.7	7.9	581.46	271.70	36
T51	28	6	100	10.1	11.37	7.6	7.0	8.0	7.5	606.60	306.36	40
T52	32	6	100	6.5	12.63	8.4	7.9	8.4	8.2	485.79	364.40	45
T53	20	8	100	7.8	12.71	8.4	8.2	8.8	8.5	309.41	226.30	32
T54	24	8	100	5.7	11.54	7.6	8.5	8.7	8.3	394.96	314.31	36
T55	28	8	100	6.9	12.50	8.6	8.2	8.6	8.5	498.96	305.30	40
T56	32	8	100	4.2	13.23	8.4	8.7	9.0	8.7	386.09	370.68	45
T57	20	10	100	5.9	10.11	8.5	7.6	8.8	8.3	299.05	289.44	32
T58	24	10	100	4.4	11.93	8.3	8.9	8.8	8.7	419.73	401.54	36
T59	28	10	100	3.2	10.33	8.5	8.6	8.6	8.6	581.20	491.17	40
T60	32	10	100	4.0	11.06	9.0	8.7	8.7	8.8	401.34	343.80	45
T61	20	12	100	3.8	9.69	8.8	8.2	8.8	8.6	278.31	250.96	32
T62	24	12	100	2.7	12.45	8.6	8.2	8.9	8.6	315.46	307.11	36
T63	28	12	100	2.5	10.43	8.9	8.9	9.0	8.9	354.98	344.49	40
T64	32	12	100	2.7	11.58	8.7	8.4	8.7	8.6	423.47	396.69	45
Control*				-	8.1	8.0	6.8	5.5	6.8	633.00	5.5	-

* Sample from local reputed *Kajukatli* manufacturer

Table 4.2: ANOVA for total effect of processing parameters on responses

Source	D.F.	S.S.	M.S.	F	P
Average particle size of cashew paste					
WA	3	28.542	9.514	8.13	<0.001
GT	3	300.961	100.320	81.32	<0.001
Error	57	70.319	1.234		
Total	63	10.42219			
Moisture content					
WA	3	4.486	1.495	0.65	0.586
GT	3	1.079	0.360	0.16	0.925
CT	3	4.290	1.430	0.62	0.604
Error	54	124.130	2.299		
Total	63	133.985			
Color and appearance					
WA	3	1.9609	0.65353	11.93	<0.001
GT	3	3.81732	1.27244	23.22	<0.001
CT	3	1.68547	0.56182	10.25	<0.001
Error	54	2.95882	0.05479		
Total	63	10.42219			
Body and texture					
WA	3	1.6610	0.5537	4.12	0.011
GT	3	3.0410	1.0137	7.55	<0.001
CT	3	2.6720	0.8907	6.63	0.001
Error	54	7.2507	0.1343		
Total	63	14.6247			
Flavor					
WA	3	0.10446	0.03482	1.27	0.295
GT	3	0.33314	0.11105	4.04	0.012
CT	3	1.40806	0.46935	17.08	<0.001
Error	54	1.48390	0.02748		
Total	63	3.32955			
Overall acceptability					
WA	3	0.85719	0.28573	8.90	<0.001
GT	3	1.85838	0.61946	19.29	<0.001
CT	3	1.80223	0.60074	18.70	<0.001
Error	54	1.73449	0.03212		
Total	63	6.25229			
Hardness					
WA	3	69550	23183	6.31	0.001
GT	3	101719	33906	9.23	<0.001
CT	3	359700	119900	32.65	<0.001
Error	54	198319	3673		
Total	63	729289			
Yield point					
WA	3	71043	23681	19.27	<0.001
GT	3	15708	5236	4.26	0.009
CT	3	150121	50040	40.72	<0.001
Error	54	66354	1229		
Total	63	303226			

4.1.1Average particle size of cashew nut paste

Average particle size of cashewnut paste was found in the range of 2.32-12.9µm (Table 4.1). Minimum average particle size was observed at 24% water addition and grinding time of 12 min (T14). Whereas, maximum average particle size was at 20% water addition and grinding period of 6 min (T17). The effect of water addition while grinding and grinding time was significant at significance level of P<0.001 (Table 4.2). Average particle size decreases as water addition or grinding time increases in the range studied (Fig 4.1). Further addition of water resulted in non-uniform ground mass. Optimum particle size and range will result in acceptable product.

Response model comprise of linear and interactive term was observed significant to explain 88.8% variation (Table 4.3) in the response values (Table 4.1). From the ANOVA analysis, it can be observed that grinding time has higher effect than addition of water. Interactive effect on the response was positive (Fig 4.2) and significant (Table 4.3). Positive significant effect suggests that level of one variable can be increase while other can be decreased for constant response value. Addition of water during grinding eases the cashewnut cutting/grinding and provides fine uniform paste.

Table 4.3: ANOVA for average particle size of cashew paste

Source	D.F.	SS	MS	F	P
Model	15	354.95	23.66	25.31	<0.0001
A-WA	3	29.32	9.77	10.45	<0.0001
B-GT	3	299.97	99.99	106.9	<0.0001
AB	9	24.66	2.74	2.93	0.0075
Residual	48	44.88	0.93	4.42	
Lack of Fit	47	44.66	0.95		
Pure Error	1	0.21	0.21		
Cor Total	63	399.82			
R^2 value: 0.888			Adj R^2 value: 0.853		

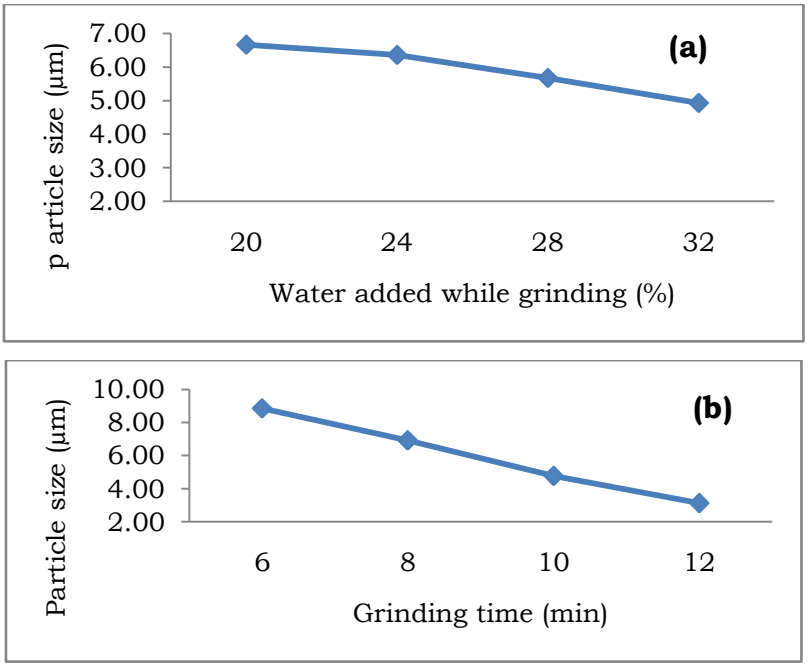


Fig. 4.1 Average particle size of cashew paste v/s a) water added for grinding and b) grinding time

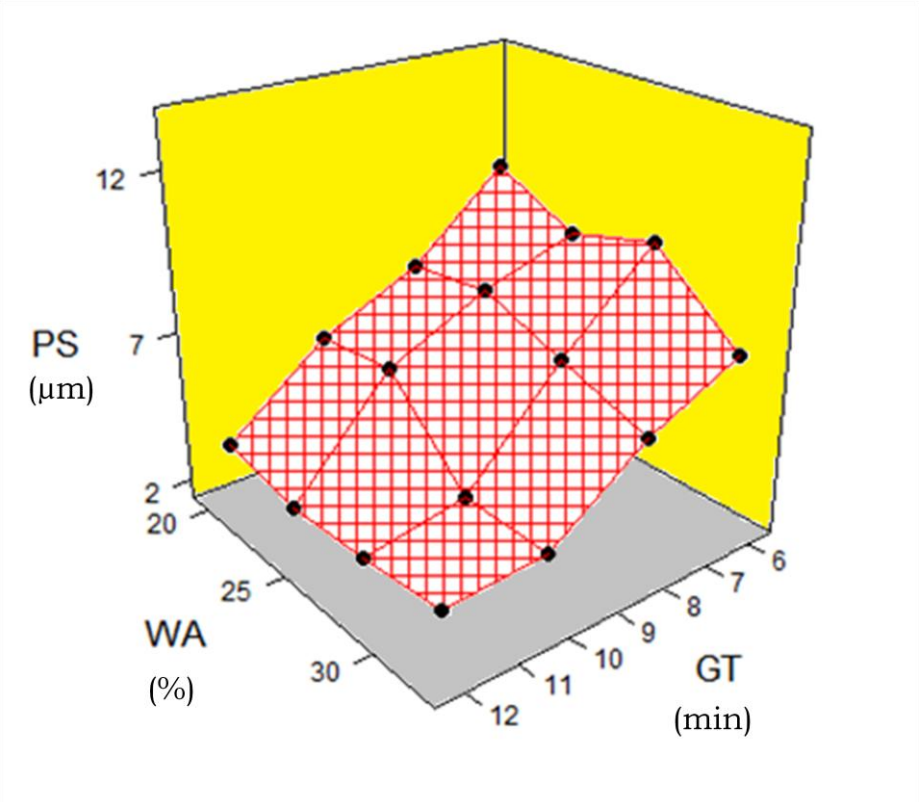


Fig. 4.2 Average particle size of cashew paste in µm as function of water added while grinding and grinding time

4.1.2 Effect on moisture content of *Kajukatli*

The moisture content of samples was found to be in range of 8.6 to 17.9%d.b. (Table 4.1). Control sample was having moisture control of about 8.1%. The effect of processing variables was non-significant (Table 4.2). However, moisture content of the product play important role as it affects sensory and textural properties and storage life of the product. The variation in moisture content might be due to uncontrolled cooling and cooking end point judgment of cashew paste-sugar mixture.

4.1.3 Effect of the processing parameters on sensory attributes of *Kajukatli*

4.1.3.1 Color and appearance

The sensory score for color & appearance of prepared *Kajukatli* samples was found in the range of 7.3 to 9.0 (Table 4.1). The lowest score was observed for sample prepared at conditions T1. Judges assessed highest score 9.0 for the samples prepared using condition at T47 and T60. All three process parameters had statistically significant total and linear effect (Table 4.2 and 4.4). The variance ratio, F value, of grinding time was higher and about twice of other processing parameters i.e. water added while grinding and cooking temperature. The effect may be due to lower average particle size of the paste, 2.7-4.0 μm for maximum score (Table 4.1), therefore better mixing with sugar and cooked appearance. The interaction effects were found to be non significant. However, from the Fig 4.3, 4.4 and 4.5, it can be observed that higher water addition and grinding time with cooking at temperature ~90˚C would produce samples of higher scores for colour and appearance.

4.1.3.2 Body and texture

Kajukatli samples should not be too hard for bitting and too soft for retention of size and shape. The product is well known and accepted for its characteristic soft body and texture. The samples were judged by panel members and score was found in the range of

Table 4.4: ANOVA for color and appearance of *Kajukatli* samples

Source	D.F.	SS	MS	F	P
Model	9	7.60	0.84	16.14	<0.0001
A-WA	3	*2.10*	*0.70*	*13.35*	<0.0001
B-GT	3	*3.84*	*1.28*	*24.50*	<0.0001
C-CT	9	*1.61*	*0.54*	*10.25*	<0.0001
Residual	54	2.82	0.052	*863.28*	
Lack of Fit	53	*2.82*	*0.053*		0.0270
Pure Error	1	*6.17E-005*	*6.17E-005*		
Cor Total	63	10.42			
R^2 value: 0.729			Adj R^2 value: 0.683		

Table 4.5: ANOVA for body and texture of *Kajukatli* samples

Source	D.F.	SS	MS	F	P
Model	9	7.50	0.83	6.32	<0.0001
A-WA	3	*1.79*	*0.60*	*4.53*	0.0067
B-GT	3	*3.06*	*1.02*	*7.73*	0.0002
C- CT	9	*2.71*	*0.90*	*6.85*	0.0005
Residual	54	7.12	0.13		
Lack of Fit	53	*7.00*	0.13	1.06	0.6651
Pure Error	1	*0.13*	0.13		
Cor Total	63	14.62			
R^2 value: 0.513			Adj R^2 value: 0.431		

Table 4.6: ANOVA for flavor of *Kajukatli* samples

Source	D.F.	SS	MS	F	P
Model	9	1.41	0.47	14.66	<0.0001
C- CT	3	1.41	0.47	14.66	<0.0001
Residual	60	1.92	0.032		
Lack of Fit	59	1.92	0.032	6.50	0.3038
Pure Error	1	5.000E-003	5.000E-003		
Cor Total	63	3.33			
R^2 value: 0.422			Adj R^2 value: 0.394		

Table 4.7:ANOVA for overall acceptability of *Kajukatli* samples

Source	D.F.	SS	MS	F	P
Model	9	4.50	0.50	15.44	<0.0001
A-WA	3	8.84	0.28	8.66	<0.0001
B-GT	3	1.86	0.62	19.12	<0.0001
C- CT	9	1.79	0.60	18.39	<0.0001
Residual	54	1.75	0.032		
Lack of Fit	53	1.73	0.033	1.57	0.5713
Pure Error	1	0.021	0.021		
Cor Total	63	6.25			
R^2 value: 0.720			Adj R^2 value: 0.673		

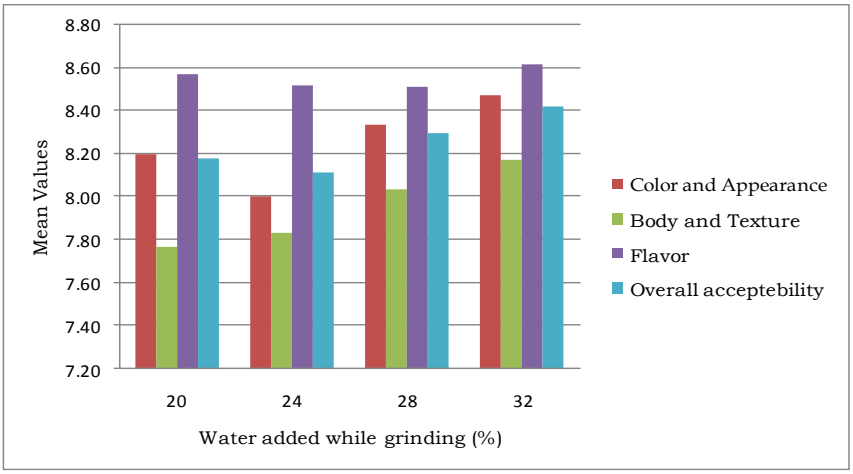


Fig.4.3 Sensory attributes of *Kajukatli* samples v/s water added while grinding

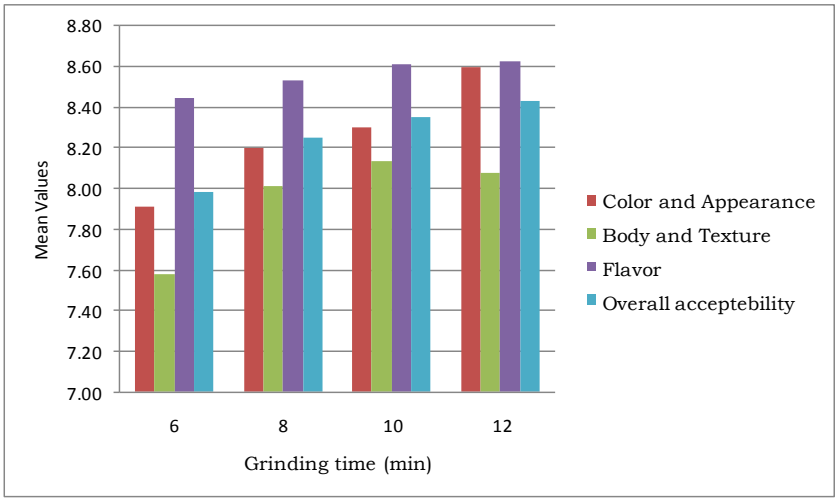


Fig.4.4 Sensory attributes of *Kajukatli* samples v/s grinding time

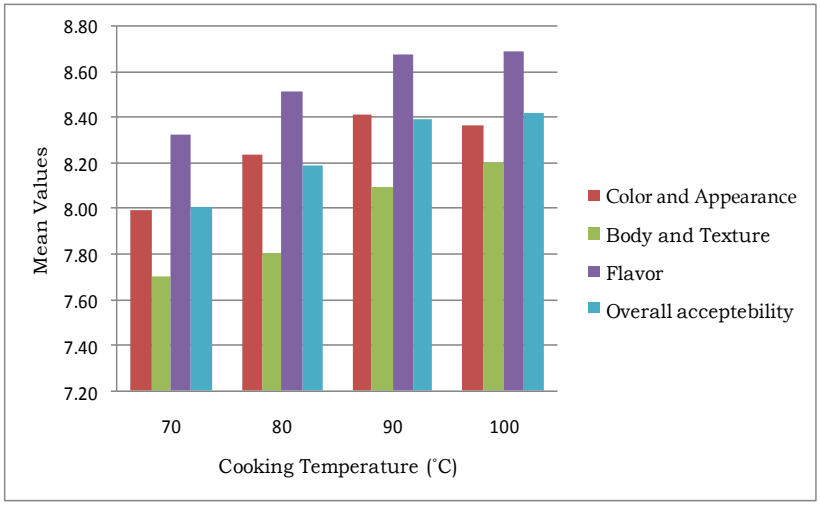


Fig.4.5 Sensory attributes of *Kajukatli* samples v/s cooking temperature

7.0 (T3, T30 & T51) - 8.9 (T58 & T63) as shown in Table 4.1. The higher score were at lower average particle size 2.5-4.4 µm (T58 & T63) indicates better acceptability of samples in terms of body and texture. The score for control sample was 6.80. Grinding time and cooking temperature had significant effects (Table 4.2 and 4.5) at 99% confidence level. The interactive effects among the variables were not significant. From the Fig 4.3, 4.4 and 4.5, it can be said that increase in the cooking temperature and grinding time resulted in higher score.

4.1.3.3 Flavor

Sensory score in terms of flavor (Table 4.1) was found in the range of 8.0 (T3) to 9.0 (T44, T56 & T63). The variation may be due to development of flavoring/aroma compounds during cooking of cashewnut paste and sugar mix. Cooking temperature had significant positive effect at P<0.001 (Table 4.2 & 4.6 and Fig 4.5). **Jayalekshmy and Narayanan (1989)** and **Garruti** *et al* **(2003)** isolated the flavor constituents especially ethyl and methyl esters of saturated carboxylic acids from C2 to C6 and pyrazines.However, detail study required involving chromatographic and olfactometric, and dynamic headspace technique for identifying the contributing compounds.

4.1.3.4 Overall acceptability

Overall acceptability score of the *Kajukatli* preparations at different experimental combinations was in the range of 7.5 (T51) to 8.9 (T63). The score of the all preparations was higher than control sample. During sensory assessment, panel judges observed that market and control sample have higher sugar and it's after-taste effect. Whereas, laboratory preparations enunciate more cooked cashewnut flavor, which was highly desirable and acceptable. All the study process parameters had significant linear effect at P<0.001 (Table 4.2 & 4.7). Cooking temperature and grinding time had twice higher effect than of water addition while grinding. However, response model comprise of only linear terms was significant (P<0.001) to explain 72% variation in the values. Difference in the coefficient of

determinations is acceptable within 20 percent for predicting the scores. From the mean value graphs (Fig 4.3-4.5), it can be observed that increase in the level of variables indicates increase in overall acceptability score.Overall it be concluded from the sensory scores analysis that uniform and fine grinding of soaked cashewnut splits and cooking the mix at higher temperature would give higher scores in terms of higher color and appearance, body and texture, flavor and overall acceptability.

4.1.4 Effect of processing parameters on textural attributes of *Kajukatli*

Textural attributes: hardness and yield point were measured from the recorded TPA curve (Fig 3.4), between force and time at the specified test setting (Pre-test speed 7 mm/s, Test speed 1 mm/s, Post-test speed 10 mm/s and travel distance 35 mm) using Texture Analyzer (TA-HDi, Stable Micro system, UK) and Warner Bratzler test blade, of each test samples in triplicate as explained in section 3.7.5.

4.1.4.1 Hardness

Hardness refers to the peak force that resulted from the Texture Profile Analysis of the *Kajukatli* samples are shown in Table 4.1. The value ranges from 142.45 g (T1) to 606.60 g (T51). ANOVA analysis, Table 4.2 & 4.8 showed that grinding time and cooking temperature had higher significant effects at significance level of $P<0.001$. Cooking temperature had about three times higher effect then other parameters studies.

The variation in the hardness values may be due to cohesive effect of final moisture content, sugar and ground cashewnut and preparation process. The textural properties developed during product formation by distribution of fine cashewnut and interaction with various sugar forms during the cooking and cooling processes at different level of temperature, time and rates. The ground mass mixture first had crystal raw sugar which melts during cooking and get mixed with available water and fine particles of cashewnut. No literature is available regarding phenomenon responsible for different

hardness and yield point of the product therefore; further study may be conducted to study the phenomenon.

Fig 4.6 to 4.8 shows mean values of hardness and yield point. It can be seen that increase in cooking temperature increase in the hardness values. Same trend was observed in sensory evaluation of body and texture (Fig 4.5). Water addition while grinding had similar trend (Fig 4.3 & 4.6). However, grinding time resulted negative effect i.e. increase in grinding time result in less harder product (Fig 4.4 & 4.7). Fig 4.9 shows the combined effect of individual and interaction on hardness. Increase in cooking temperature and grinding time produces harder product.Control sample was observed to have higher hardness value (633.0 g), than all prepared test samples, which might be due to higher content of sugar as observed by panel judges.

4.1.4.2 Yield point

Yield point can be defined as minimum force that causes first significant breakage in the sample. ANOVA for yield point values of *Kajukatli* samples (Table 4.2& 4.9), showed that water added while grinding and cooking temperature had significant and linear effects at $P<0.01$.The values ranged from 138.67 (T13)-491.17 (T59), shown in Table 4.1and lesser than control sample value of 573.91 g. Fig. 4.6 to 4.8 shows that mean values increases as level of cooking temperature and water addition increases. The reason might be the strength of the product formation due to cohesive effect of ingredients and heat transfer processes.

It can be concluded from the above observations that the product should have higher sensory scores of flavor, body and texture and overall acceptability. Hardness and yield point should be corresponding to the maximum scores but below then control sample values.

Therefore, optimization/standardization for maximization of body and texture and overall acceptability scores and minimization of final moisture content keeping other response values within the range suggested following experimental combinations.

Table 4.8: ANOVA for hardness of *Kajukatli* samples

Source	D.F.	SS	MS	F	P
Model	18	6.068E+005	33712.76	12.39	<0.0001
A-WA	3	61133.46	20377.82	7.49	0.0004
B-GT	3	1.018E+005	33937.94	12.47	<0.0001
C- CT	3	3.635E+005	1.212E+005	44.53	<0.0001
BC	9	82886.98	9209.66	3.38	0.0030
Residual	45	1.225E+005	2721.31		
Lack of Fit	44	1.167E+005	2652.11	0.46	0.8525
Pure Error	1	5766.33	5766.33		
Cor Total	63	7.293E+005			
R^2 value: 0.832			Adj R^2 value: 0.764		

Table 4.9: ANOVA for yield point of *Kajukatli* samples

Source	D.F.	SS	MS	F	P
Model	6	2.208E+005	36808.12	25.47	<0.0001
A-WA	3	70727.87	23575.96	16.31	<0.0001
C-CT	3	1.526E+005	50864.70	35.20	<0.0001
Residual	57	82377.55	1445.22		
Lack of Fit	56	79726.97	1423.70	0.54	0.8221
Pure Error	1	2650.59	2650.59		
Cor Total	63	3.032E+005			
R^2 value: 0.728			Adj R^2 value: 0.699		

Table 4.10: Optimum/standard conditions of desirable responses

No.	WA	GT	CT	PS	FMC	BT	OA	H	YP	t
O1	32	12	100	3.35	11.39	8.3	8.8	350.40	353.45	45
O2	32	10	100	3.50	11.39	8.4	8.7	432.67	353.45	45
O3	28	12	100	2.97	11.39	8.3	8.7	377.34	341.10	40
O4	32	10	90	3.35	11.39	8.2	8.7	305.75	301.55	48

Design Expert software (version: 8.7.0.1) was used for the purpose. Samples were prepared considering the processing condition specified in O1 and kept for storage study.

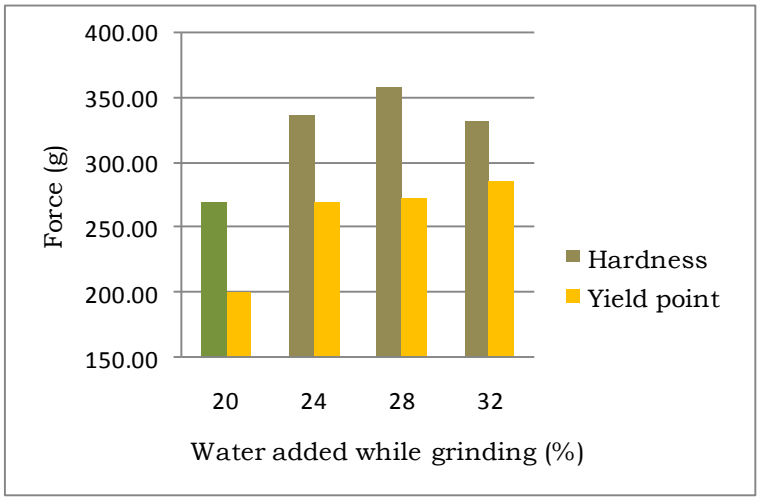


Fig.4.6 Textural attributes of *Kajukatli* samples v/s water added while grinding

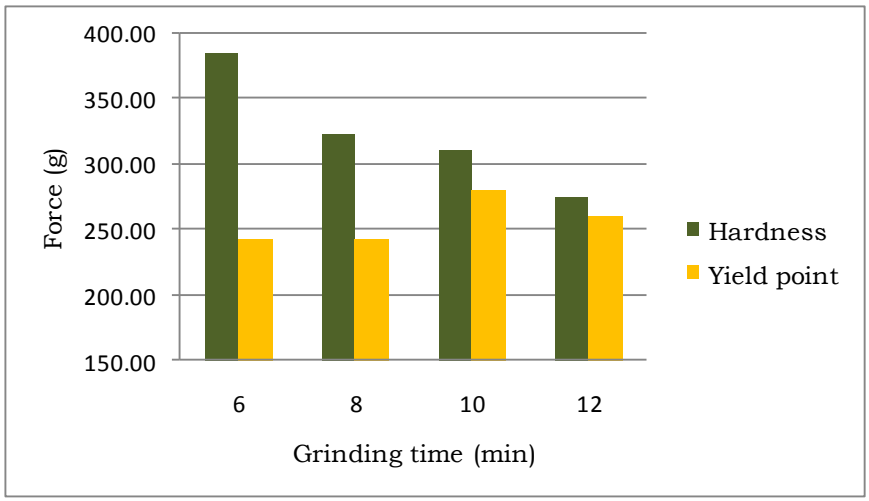


Fig.4.7 Textural attributes of *Kajukatli* samples v/s grinding time

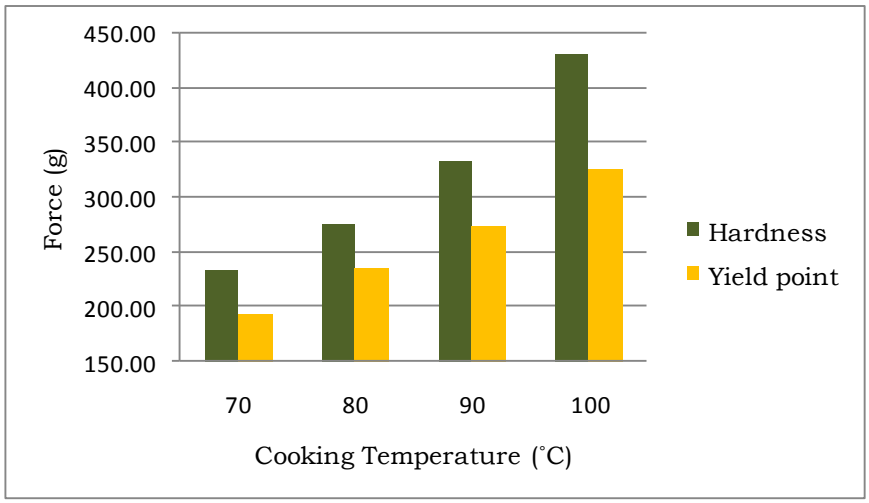


Fig.4.8 Textural attributes of *Kajukatli* samples v/s cooking temperature

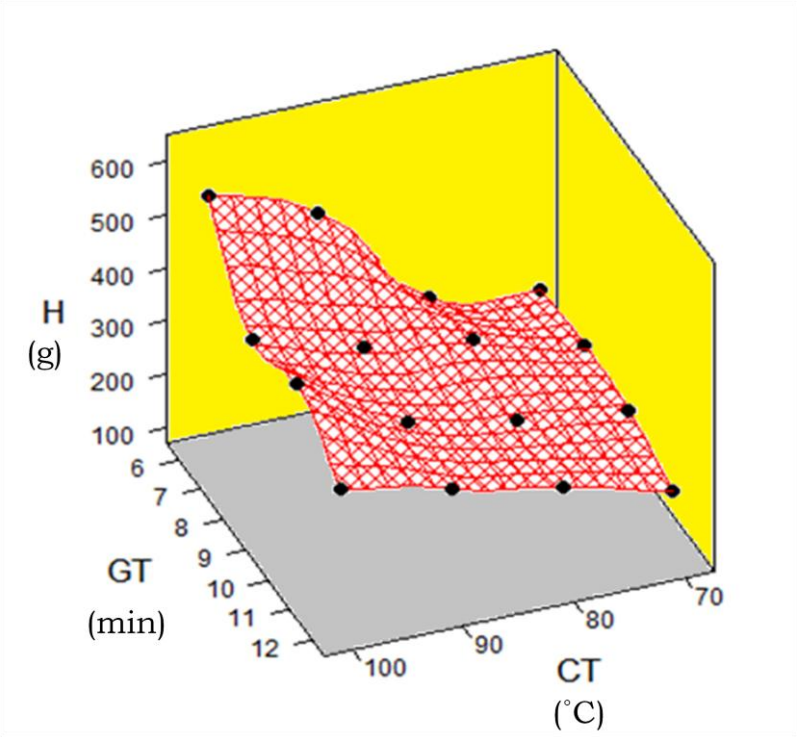


Fig. 4.9 Hardness of *Kajukatli* samples as function of grinding time and cooking temperature

Plate 4.1 *Kajukatli* prepared at standardized conditions

4.2 Comparison of physicochemical parameters of control sample and standardized sample

Table 4.11 indicates the physicochemical parameters of standardized and control (market) *Kajukatli* samples. From the table, it can be observed that the moisture content of standardized sample was more as compared to market sample. It may be due to that the market sample taken for analysis was not freshly prepared and was stored for some time, which may result in the moisture loss to the exposure to atmosphere.

Table 4.11: Comparison of physicochemical parameters of standardized sample and control sample

Parameters	Standardized Sample	Control Sample
Moisture (%)	10.17 ± 0.028	8.2 ± 0.24
Fat (%)	24.37 ± 0.3	21.0 ± 0.2
Protein (%)	25.8 ± 0.23	22.0 ± 0.51
Ash (%)	0.93 ± 0.004	0.88 ± 0.03
Carbohydrate (%) by diff.	3.26	1.92
Sugar (%)	35.47 ± 0.42	46.0 ± 0.38
Water activity (a_w)	0.791 ± 0.0034	0.756 ± 0.003

The fat and protein content of the standardized sample was higher than that of control sample because the 65% of cashewnut splits was used in the standardized sample, whereas only 50% of cashewnut splits was used in control sample **(Parmar, 2012)**. The control sample was observed to be sweeter than the standardized sample. Former contained 10% more sugar.

4.3 Storage study

A food product must have adequate keeping quality, so that the product could withstand the environmental conditions and reach to the consumers with satisfactory quality. A variety of spoilage changes are expected to occur in the product as the storage period progresses. These changes are influenced by variety of factors like storage temperature, type of packaging material, humidity and environment

within the product container. So, as to have a glance towards the changes that might be taking place this storage study was conducted.

The *Kajukatli* samples prepared at optimized/standardized condition (32% at water addition while grinding, 12 min grinding time and cooking at 100˚C for 45 min) were packed in commercially available PVC containers (Plate 4.1) at room condition having temperature of 30±2˚C & 65% RH and refrigeration condition having temperature of 6±2˚C & 90% RH for periodic evaluation. The *Kajukatli* samples stored at room condition were analyzed at an interval of 3 days till visible growth of yeast or/and mold. The samples stored at refrigeration condition were analyzed at an interval of 6 days and up to 30 days.

The physical, sensory, textural and microbiological attributes were analyzed to find the changes taking place in the prepared *Kajukatli* sample stored in the specified condition and period. The parameters like moisture content and water activity; sensory scores of color and appearance, body and texture, flavor and overall acceptability; textural attributes in terms of hardness and yield point and microbiological parameters such as Total Plate Count (TPC) and Yeast and Mold Count (YMC) of the stored samples, in triplicate, were analyzed. The mean values are shown in the following Tables 4.12-19 and discussed below.

4.3.1 Moisture content and water activity of the stored *Kajukatli* samples

The moisture content and water activity reported to be important factors to affect the keeping quality and texture of the product. The slight deviation in the moisture content can result in softer or harder texture. Similarly change in water activity (a_w) may favor growth of bacteria and fungi which requires minimum water activity of 0.91 and 0.7 respectively for their support of growth **(Parmar, 2012; Macwan 2012)**.

Table 4.12 showed that moisture content of samples stored in room condition decreased from initial level of 9.62 to 6.73% (w/w

basis) on 12th day. The change in values was significantly different to each other consecutively and from initial value. Similarly, water activity of the stored samples decreases as storage period progressed. The initial value was 0.78 and it remains higher on 12th day of storage then safe value of 0.7. However, after ninth day of storage visible fungal growth was observed. Table 4.13 depicted results for refrigerated condition, whereas moisture content of the product decreases from 9.62% gradually but significantly after sixth day of storage. At the end of thirty days of storage moisture content of the product was 7.59%. Similarly, initial water activity was 0.78 and it decreased to 0.72 at the end of 30 days. The difference among consecutive analysis noted as * was significant at significance level of 0.05. During the course of refrigerated storage no visible growth of microorganism was observed. **Parmar (2012)** reported similar trends during storage study at room and refrigerated condition for the period of ten days. **Sachdeva and Rajhoria (1982)** also reported decrease from initial 23.84% moisture content of plain *burfi* during storage at 30˚C to 15.44% at the end of 10 days. The change reported due to loss of product's moisture, thereby decrease in water content and activity.

4.3.2 Sensory characteristics of stored *Kajukatli* samples

The sensory scores of color and appearance, body and texture, flavor and overall acceptability of the stored *Kajukatli* samples at room and refrigeration condition have been depicted in Table 4.14 and 4.15, respectively.

The consecutive changes in scores of color and appearance, flavor, and body and texture were not significant up to three, six and six days, respectively. After that decrease in scores were significant at the 5% level. Values for overall acceptability had been decreasing significantly ($P \leq 0.05$) to 4.5 (Table 4.14). Which indicated that product was no more acceptable for consumption. The significant change in scores may be attributed to discoloration i.e. white-creamish to dark-creamish or browning, change in flavor and hardness due to rancidity

Table 4.12:Physical characteristics of stored samples at room condition (30±2˚C& 65% RH)

Parameters	Days					SE_m	$CD_{(0.05)}$	C.V. %
	0	3	6	9	12			
Moisture content	9.62	8.66*†	8.18*†	7.64*†	6.73*†	0.032	0.356	13.262
Water activity	0.78	0.77	0.75†	0.74*†	0.73†	5.29E-05	0.015	2.940

Table 4.13: Physical characteristics during storage at refrigerated condition (6 ±2˚C &90% RH)

Parameters	Days						SE_m	$CD_{(0.05)}$	C.V. %
	0	6	12	18	24	30			
Moisture content	9.62	9.42	8.67*†	8.39†	7.99*†	7.9†	0.0316	0.364	7.791
Water activity	0.78	0.77	0.76*†	0.74*†	0.72*†	0.72†	3.28E-05	0.011	3.593

Table 4.14: Sensory scores of samples during storage at room condition at(30±2˚C& 65% RH)

Parameters	Days					SE_m	$CD_{(0.05)}$	C.V. %
	0	3	6	9	12			
Color & appearance	8.8	8.2	7.7†	6.0*†	4.7*†	0.142	0.752	24.087
Flavor	8.7	8.5	8.0	5.5*†	4.2*†	0.163	0.805	28.976
Body & Texture	8.7	8.2	7.8	5.3*†	4.7†	0.300	1.094	26.035
Overall acceptability	8.7	8.3	7.7	5.7*†	4.5*†	0.254	1.007	25.899

*****Significantly different from previous analysis at significance level of 0.05 %
†Significantly different from fresh sample at significance level of 0.05 %

Table 4.15: Sensory scores of samples during storageat refrigerated condition (6 ±2˚C&90% RH)

Parameters	Day						SE_m	$CD_{(0.05)}$	C.V. %
	0	6	12	18	24	30			
Color & Appearance	8.8	8.2*†	7.2*†	7.0†	7.0†	6.3*†	0.042	0.381	12.288
Flavor	8.7	8.3	8.0	7.3†	6.5*†	6.2†	0.158	0.742	13.481
Body & Texture	8.7	8.2*†	8.0†	7.3*†	7.0†	6.3*†	0.058	0.450	11.271
Overall acceptability	8.7	8.2	7.8	7.2†	6.7†	6.2†	0.181	0.792	12.717

Table 4.16: Textural characteristics during storage at roomcondition at (30±2˚C& 65% RH)

Parameters	Days					SE_m	$CD_{(0.05)}$	C.V. %
	0	3	6	9	12			
Hardness (g)	388.09	435.86*†	573.96*†	653.54*†	719.26*†	67.21	16.37	25.38
Yield point (g)	368.17	396.46	415.57†	536.06*†	673.99*†	505.05	44.88	26.54

Table 4.17: Textural characteristics during storageat refrigerated condition (6 ±2˚C&90% RH)

Parameters	Days						SE_m	$CD_{(0.05)}$	C.V. %
	0	6	12	18	24	30			
Hardness (g)	388.09	402.75	465.85	552.85*†	619.52†	681.63†	2130.15	86.03	23.01
Yield point (g)	368.17	387.26	374.00	464.55*†	474.52†	506.37†	652.17	47.60	13.90

*****Significantly different from previous analysis at significance level of 0.05 %
†Significantly different from fresh sample at significance level of 0.05 %

Table 4.18: Microbiological parametersduring storage at room temperature (30±2˚C& 65% RH)

Parameters	Days				SE_m	$CD_{(0.05)}$	C.V. %
	0	3	6	9			
SPC (log cfu/g)	2.42	3.40*†	4.14*†	4.35†	0.0478	0.489	24.44
YMC (log cfu/g)	0.00	1.73*†	1.97†	2.38†	0.0361	0.424	68.97
Coliform count (log cfu/g)	Nil	Nil	Nil	Nil	-	-	-

Table 4.19: Microbiological parameters during storage at refrigeration temperature (6 ±2˚C&90% RH)

Parameters	Days						SE_m	$CD_{(0.05)}$	C.V. %
	0	6	12	18	24	30			
SPC (log cfu/g)	2.42	3.29*†	3.95*†	4.18†	4.25†	4.32†	0.04	0.36	19.99
YMC (log cfu/g)	0.00	1.20*†	1.13†	1.59†	1.73†	1.82†	0.17	0.77	20.58
Coliformcount (log cfu/g)	Nil	Nil	Nil	Nil	Nil	Nil	-	-	-

*****Significantly different from previous analysis at significance level of 0.05 %
†Significantly different from fresh sample at significance level of 0.05 %

and loss of moisture, thereby reducing the overall acceptability of the product.

Whereas, in refrigerated condition, changes in scores for overall acceptability and flavor were not significant up to 18 days. After that the product loose scores significantly ($P \leq 0.05$) up to 6.2 for overall acceptability and flavor (Table 4.15). Scores for body and texture and flavor were decreasing significantly from the first evaluation i.e. sixth day. The non-significant changes may be attributed to retention of flavor, body and texture, slight variation in color and appearance thereby overall acceptability. The significant score difference of successive evaluations were observed, by panelist, due to change in body and texture of product experiencing slow- moisture migration to environment, change of color and appearance and loss of flavor.

From the above sensory evaluation, it could be concluded that product was having acceptable scores after the studied period of more than 30 days storage having specified refrigerated condition.

4.3.3 Textural characteristicsof stored *Kajukatli*samples

The textural characteristics of *Kajukatli* samples stored at room and refrigeration condition have been reported in Table 4.16 and4.17, respectively.

Table 4.16 and 4.17 depicted the hardness and yield point values were significantly increased from initial values of 388.09 and 368.17 g, respectively over the storage period in both conditions. The increase may be attributed to the loss of free moisture from the product and explain lower sensory score particularly body and texture. When compared with control sample, yield point remains lower at the end of nine and thirty days of storage at room and refrigerated conditions, respectively.

4.3.4 Microbiological parameters of stored *Kajukatli*samples

The parameters such as: total plate count i.e. bacterial (TPC) and yeast and mold count (YMC) represent collective enumeration of the overall microbial quality of the product, just after preparation and during storage period. The separate and specific analysis for the

presence of coliform was conducted periodically and found to be absent throughout storage period at room and refrigerated conditions. The result compiled in form of log of number of colony forming units observed per g of stored *Kajukatli* samples (in triplicates) and reported in Table 4.18 and 4.19. Initial mean values of TPC, Y&M and Coliform were 2.42, 0.00 and nil, respectively.

During the course of storage at room condition TPC and YMC were increased significantly at $P \leq 0.05$. At the end of ninth day fungal growth was clearly visible and had YMC and TPC of 2.38 and 4.35 log cfu/g, respectively. Therefore, further study was discontinued and can be concluded that product became unsafe for consumption. However, during refrigerated storage, the rate of increments were lower and at the end of thirty days there was no visible fungal growth and the product had YMC and TPC of 1.82 and 4.32 log cfu/g, respectively.

Ghodekar (1969) found that *burfi* stored at 37˚C storage condition had total bacterial count (TPC) ranging from 1,100-5,000 cfu/g, yeast count 40-6,500 cfu/g and mold count in the range of 20-3,00,000 cfu/g. Microbiological changes, in terms of TPC and YMC during storage of plain *burfi* at 30˚C reported to be increased from 200 cfu/g to 2000 cfu/g and from zero to 180×10^3 cfu/g, respectively **(Sachdeva and Rajhoria, 1982)**. **Macwan (2012)** reported shelf life of standardized *khoa* based *kajukatli* as 2 days and more than 28 days when stored at room temperature (30±2˚C) and at refrigeration temperature (7±2˚C), respectively.

Based on above observations, it can be concluded that the prepared *Kajukatli* were suitable for consumption up to 9 days at room condition of 30±2˚C & 65% RH and more than 30 days at refrigeration condition of 6±2˚C & 90% RH.

CHAPTER V

Summary and Conclusions

The *Kajukatli* preparation process varies from halwais to organized sector. A number of variables influence the final product quality such as raw material, average particle size of ground cashew and moisture content before cooking, mixing with sugar, cooking temperature and time, cooking and cooling rate etc **(Parmar 2012)**. From the preliminary trials, it was observed that unit operations such as grinding and cooking play important role in deciding the quality/desirability of the final product. A systematic study on the effect of grinding and cooking parameters will be therefore useful for uniform quality production. Hence, this study was undertaken to study the effect of grinding and cooking parameter on quality of *Kajukatli* and storability of *Kajukatli* prepared at optimize condition for maximum score of sensory parameters and minimum final moisture content.

Kajukatli samples were prepared using cashewnut splits by addition of water for grinding at different level of 20, 24, 28 & 32% weight of soaked cashew splits and ground for 6, 8,10 & 12 min in laboratory grinder. The moisture content of cashewnut paste so prepared was found as 49.68±1.34, 55.56±3.04, 60.02±1.74, 66.53±2.09% d.b., respectively. The cashewnut paste was then mixed with sugar in the ratio of 65:35 and cooked using cooking assembly consisting of thick bottom S.S. top, scraper and water bath maintained at different temperature levels at 70, 80, 90 & 100°C. The mass was stirred manually with help of scraper until it starts leaving the surface of the cooking vessel. Since mass was having different moisture content and cooking temperature, the cooking time observed was in the range of 32 min to 70 min. The cooked mixture was then immediately transferred and cooled in another vessel up to 42°C, then transferred on SS flatbed for rolling and sheeting using hand roller

(*bellan*) to the thickness of 5 mm and cut by knife in the diamond shape having size of 3 cm × 3 cm using a SS scale.

Total 64 experiments were conducted following factorial design and samples were evaluated for particle size, moisture content, sensory attributes (color and appearance, flavor, body and texture and overall acceptability), textural attributes (hardness and yield point) and microbiological attributes (TPC, YMC and Coliform count) following standard procedure.

Kajukatli prepared with 28% water addition, grinding for 12 min and cooking at 100˚C temperature had highest overall acceptability. The samples prepared at this optimized condition were packed in commercially available PVC containers for storage study at room condition of 30±2˚C & 65% RH and refrigerated condition of 6±2˚C & 90% RH. The *Kajukatli* stored at room temperature was analyzed for sensory, textural and microbial parameters at an interval of 3 days till visible fungal growth. Similarly, samples stored at refrigeration condition were analyzed at an interval of 6 days up to 30 days.

The following conclusions could be drawn from the present investigation:

1. Average particle size of cashew paste prepared under different treatment combinations were ranged from 2.32 to 12.86 µm. Both, water added during grinding and grinding time had significant effect on average particle size of cashew paste.
2. Sensory score of *Kajukatli* samples in terms of color & appearance, flavor, body and texture and overall acceptability were found in the range of 7.3-9.0, 8.0-9.0, 7.0-8.9 and 7.5-8.9, respectively. Almost all sensory attributes of *Kajukatli* samples were significantly affected by water added while grinding, grinding time and cooking temperature at $P<0.01$.
3. *Kajukatli* samples prepared with water added with water added at the rate of 28%, grinding time 12 min. and cooking temperature 100˚C had highest overall acceptability (8.9).

Hardness and yield point of that sample were 354.98 and 344.49 g, respectively.

4. From the textural profile analysis, hardness and yield point of samples were observed to be in the range of 142.45-606.60 g and 138.67-491.17 g, respectively. All three factors had significant effect on hardness and yield point of the *Kajukatli* samples.
5. The samples stored at room condition of 30±2˚C & 65% RH showed significant effect of the storage period on moisture content and water activity. The fresh sample of *Kajukatli* had moisture content and water activity 9.6 and 0.78 which reduced significantly to 6.7 and 0.73 respectively at the end of 12 days of storage at room temperature.
6. Whereas, the samples stored at refrigerated condition of 6±2˚C&90% RH showed decreased in moisture content and water activity from 9.68 and 0.78 at 0^{th} day to 7.59 and 0.72on 30^{th} day. However, the rate of reduction in moisture content and water activity at refrigeration temperature was lower than that at room condition.
7. All sensory attributes of *Kajukatli* samples were significantly affected by storage at room condition of 30±2˚C& 65% RH as well as refrigeration condition 6±2˚C & 90% RH. Storage at room condition resulted in decreased product acceptance. The color and appearance (8.8), flavor (8.7), body and texture (8.7) and overall acceptability (8.7) scores of fresh *Kajukatli* samples decreased to 4.7, 4.2, 4.7 and 4.5 respectively at the end of 12 days of storage. This might be due to development of off flavor due to rancidity with impaired textural attributes. However, the product stored at refrigeration temperature remained acceptable even after 30 days of storage.
8. Room condition of 30±2˚C & 65% RH had significant effect on hardness and yield point of *Kajukatli*. Hardness and yield point

was increased from 388.09 and 368.17 g at 0th day to 719.26 and 673.99 g at 12thday of storage, respectively. The samples stored at refrigerated condition of 6±2˚C & 90% RH showed significant effect of the storage period on textural attributes. The hardness and yield point value of sample stored at refrigerated condition increased significantly to 681.63 and 506.37 g, respectively at the end of 30 days.

9. The microbial analysis revealed that TPC as well as YMC of Kajukatli was significantly changed during the course of storage study at room condition of 30±2˚C & 65% RH as well as refrigerated condition of 6 ±2˚C & 90% RH. Fresh sample had TPC of 2.42 log cfu/g which increased significantly to 4.35 log cfu/g at the 9th day of storage at room condition. Whereas, in the refrigerated condition TPC increased to 4.32 log cfu/g at 30th day of storage. Regarding YMC, initially they were absent and increased to 1.82 log cfu/g at the 30th day of storage. However, samples stored at room temperature had higher yeast and mold count as compared to *Kajukatli* stored at refrigeration condition.

CHAPTER VI

REFERENCES

Akinhanmi, T. F., Atasie, V. N. and Akintokun, P. O. (2008). Chemical composition and physicochemical properties of cashew nut (*Anacardium occidentale*) oil and cashew nut shell liquid. *Journal of Agricultural, food and environmental sciences*, 2 (1):1-10.

AOAC (1995). Official methods of analysis of the association of analytical chemists. (17th Edn). AOAC International, USA.

Bandopadhyay M., Mukharjee R. S., Chakraborty R. and Raychaudhari U. (2006). A survey on formulations and process techniques of some special Indian traditional sweets and herbal sweets. Indian Dairyman, 58(5):23-35.

Christensen, L. M. (2012). Evaluation of textural properties of cooked beef batter. A thesis submitted to faculty of California, Polytechnic state university, San Luis obiospo, USA.

Date, W. P. and Bhatia, D. S. (1955). Physico-Chemical aspects of Indigenous Dairy Products. *Journal of Dairy Science,* 8(2):61.

Garruti, D. S., M. R. B. Franco, M. A. A. P. Da Silva, N. S. Janzantti, and G. L. Alves (2003). Evaluation of volatile fl avour compounds from cashew apple (Anacardium occidentale L) juice by Osme gas chromatography / olfactometry technique. *Journal of the Science of Food and Agriculture*, 83:1455–1462.

Ghodekar, D. R. (1969). M. Sc. Thesis submitted to Bombay University, cited by Sachdeva S. and Rajorhia G. S. (1982). Technology and shelflife of burfi. *Indian Journal of Dairy Science,* 35(4):513-518.

Greenspan, L. (1976). Humidity fixed points of binary saturated aqueous solutions. *Journal of Research of the National Bureau of Standards - A. Physics and Chemistry*. 81 A(1):89-96.

Indurani, C., Jegadeeswari, V. and Arumuganthan, T. (2007). Cashew nut processing. In Science Tech Enterpreneur. 1-12.

Jasper Guy Woodruff (1970-71). Roasting and salting of cashew nuts. *Indian Cashew Journal.* 7 (2): 7-11.

Jayalekshmy A. and Narayanan C. S. (1989). Flavor constituents of roasted cashew nuts. The ACS Symposium on Thermal Generation of Aromas. Series 409: 354-365.

Kulkarni, B. S., Ramchandra, V. A. and Patil, S. M. (2012). Trends in area, production and productivity of cashew in India –An economic analysis. *International Journal of Commerce and Business Management*. 5(21):128-133.

Macwan, A. M. (2012). Technological aspects of manufacturing milk solid based kaju katri. M.Tech. Thesis, submitted to Sheth M. C. College of Dairy Science, Anand Agricultural University, Anand.

Mahesh M. S. and Nagaraja K. V. (2002). Coating of cashew kernel baby bits for value addition. *Journal of Food Science and Technology,* 39(2):124-128.

Makhecha, J. S. (2012). Shelf life study of thabdi employing different packages. M.Tech. Thesis, Submitted to Sheth M. C. College of Dairy Science, Anand Agricultural University, Anand.

Nagaraja, K.V. (2003). Preparation of spread from cashew kernel baby bits. Journal of Food Science and Technology, 40 (3):337-339.

Parmar, A. F. (2012). Studies on production of kajukatli. M.Tech. Thesis, Submitted to College of Food Processing Technology and Bio Energy, Anand Agricultural University, Anand.

Parmar, A.F., Sharma, A.K. and Joshi, D.C. (2013). Standardization of Kajukatli recipe and method. Proceeding of 47th Annual Convention of ISAE and International Symposium on Bio-Energy. p130.

Prasasd M. (1954). Storage of deep-fried salted cashew kernals. Bulletin: Central Food Technological Research Institute. 3 (9): 232.

Prasad M., Kapur N. S. and Mathur P. B. (1955). Investigations on the storage of roasted and salted cashew kernals. Journal Oil Tech. Association, India. 10: 55-63.

Ranganna, M. S. (1986). Handbook of Analysis and Quality Control for Fruits and Vegetables Products, McGraw Hill Publishing Co. Ltd., New Delhi.

Ramanna, B. R., Bhat, K. K., Mahadevaiah, B., Dwarkanath, C. T., Dhanraj, S., Potty, V. H. and Sen, D. P. (1983). Investigation on large scale preparation of milk burfi. J. Fd Sci. Technol., 20: 67-71.

Rao, R. S. and Goyal, G. K. (2007). Effect of packaging and storage on the sensory quality of kalakand. Indian Journal of Dairy Science. 60(2):77-88.

Sachdeva, S. and Rajorhia, G. S. (1982). Studies on the technology and shelf life of Burfi. Indian Journal of Dairy Science, 35 (4):513-518.

Satyanarayana Rao, T.S.; Reddy, T.H. and Jayraman, K.S. (1993). Studies on the development of cashewnut burfi. *J. Fd Sci. Technol.*, 30(2):462-464.

Senthil, A. and Mahesh, M. P. (2013). Analysis of cashew nut production in India. A*sia Pacific Journal of Marketing & Management Review,* 2 (3): 106-110

Seth S. (2010). Unlocking the Sweet Industry. http://www.indianretailer.com/article/sector-watch/food-and-grocery/Unlocking-the-Sweet-Industry-311. Accessed on 23rd May, 2013

Yadav, S. (2010). Economics of cashew in India. Department of Economic analysis and Research, NABARD. Occasional paper -50.

Table 4.12: Physical characteristics of stored samples at room condition (30±2˚C & 65% RH)

Parameters	Days					SE_m	$CD_{(0.05)}$	C.V. %
	0	3	6	9	12			
Moisture content (% wb)	9.62	8.66*†	8.18*†	7.64*†	6.73*†	0.032	0.356	13.262
Water activity	0.78	0.77	0.75†	0.74*†	0.73†	5.29E-05	0.015	2.940

Table 4.13: Physical characteristics during storage at refrigerated condition (6 ±2˚C & 90% RH)

Parameters	Days						SE_m	$CD_{(0.05)}$	C.V. %
	0	6	12	18	24	30			
Moisture content (% wb)	9.62	9.42x	8.67*†	8.39†	7.99*†	7.9	0.0316	0.364	7.791
Water activity	0.78	0.77	0.76*†	0.74*†	0.72*†	0.72†	3.28E-05	0.011	3.593

Table 4.14: Sensory scores of samples during storage at room condition at (30±2˚C & 65% RH)

Parameters	Days					SE_m	$CD_{(0.05)}$	C.V. %
	0	3	6	9	12			
Color & appearance	8.8	8.2	7.7†	6.0*†	4.7*†	0.142	0.752	24.087
Flavor	8.7	8.5	8.0	5.5*†	4.2*†	0.163	0.805	28.976
Body & Texture	8.7	8.2	7.8	5.3*†	4.7†	0.300	1.094	26.035
Overall acceptability	8.7	8.3	7.7	5.7*†	4.5*†	0.254	1.007	25.899

***Significantly different from previous analysis at significance level of 0.05 %
†Significantly different from fresh sample at significance level of 0.05 %

Table 4.15: Sensory scores of samples during storage at refrigerated condition (6 ±2˚C & 90% RH)

Parameters	Day						SE_m	$CD_{(0.05)}$	C.V. %
	0	6	12	18	24	30			
Color & Appearance	8.8	8.2*†	7.2*†	7.0†	7.0†	6.3*†	0.042	0.381	12.288
Flavor	8.7	8.3	8.0	7.3†	6.5*†	6.2†	0.158	0.742	13.481
Body & Texture	8.7	8.2*†	8.0†	7.3*†	7.0†	6.3*†	0.058	0.450	11.271
Overall acceptability	8.7	8.2	7.8	7.2†	6.7†	6.2†	0.181	0.792	12.717

Table 4.16: Textural characteristics during storage at room condition at (30±2˚C & 65% RH)

Parameters	Days					SE_m	$CD_{(0.05)}$	C.V. %
	0	3	6	9	12			
Hardness (g)	388.09	435.86*†	573.96*†	653.54*†	719.26*†	67.21	16.37	25.38
Yield point (g)	368.17	396.46	415.57†	536.06*†	673.99*†	505.05	44.88	26.54

Table 4.17: Textural characteristics during storage at refrigerated condition (6 ±2˚C & 90% RH)

Parameters	Days						SE_m	$CD_{(0.05)}$	C.V. %
	0	6	12	18	24	30			
Hardness (g)	388.09	402.75	465.85	552.85*†	619.52†	681.63†	2130.15	86.03	23.01
Yield point (g)	368.17	387.26	374.00	464.55*†	474.52†	506.37†	652.17	47.60	13.90

*****Significantly different from previous analysis at significance level of 0.05 %
†Significantly different from fresh sample at significance level of 0.05 %

Table 4.18: Microbiological parameters during storage at room temperature (30±2˚C & 65% RH)

Parameters	Days				SE_m	$CD_{(0.05)}$	C.V. %
	0	3	6	9			
SPC (log cfu/g)	2.42	3.40*†	4.14*†	4.35†	0.0478	0.489	24.44
YMC (log cfu/g)	0.00	1.73*†	1.97†	2.38†	0.0361	0.424	68.97
Coliform count (log cfu/g)	Nil	Nil	Nil	Nil	-	-	-

Table 4.19: Microbiological parameters during storage at refrigeration temperature (6 ±2˚C & 90% RH)

Parameters	Days						SE_m	$CD_{(0.05)}$	C.V. %
	0	6	12	18	24	30			
SPC (log cfu/g)	2.42	3.29*†	3.95*†	4.18†	4.25†	4.32†	0.04	0.36	19.99
YMC (log cfu/g)	0.00	1.20*†	1.13†	1.59†	1.73†	1.82†	0.17	0.77	20.58
Coliform count (log cfu/g)	Nil	Nil	Nil	Nil	Nil	Nil	-	-	-

***Significantly different from previous analysis at significance level of 0.05 %
†Significantly different from fresh sample at significance level of 0.05 %

Appendix - I

Specimen Evaluation Card

Sensory evaluation score card for *Kajukatli*

Name: - Date:-

Time:-

1. Kindly evaluate the product using 9 point hedonic scale followed by your valuable remarks and comments.
2. Remember you are the only one who can tell us what you like.
3. An honest expression of your personal feeling will help us.

Samples	Sensory parameters				
	Color Appearance	Flavor	Taste	Texture	Overall acceptability

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

Remarks/Comments:

Sign