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Storage studies on wood apple katta meeta

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Abstract
Development and standardization of wood apple Katta Meeta (candy), its acceptability, physico-chemical properties and storage stability. Woodapple (*Limonia acidissima* Linn.), commonly known as Bael. Four variations of wood apple candy (Katta meeta) containing different levels of pulp (45, 55, 65 and 75%) were prepared and compared with control (Tamarind). Proximate composition, textural attributes and microbiological quality of the developed product were determined during storage at room temperature and refrigerated temperature. Overall acceptability of candy decreased from 8.6 to 7.75 on 30th day of storage, 6.35 on 90th day of storage. WJC-4 (75%) scored lower values of 8.00, 7.80, 8.10, 7.90, 7.95 and 8.00 for appearance, texture, colour, aroma, taste and overall acceptability, respectively.

Keywords: Chemical analysis, katta meeta, organoleptic evaluation, storage, and wood apple

Introduction
Consumers are opting for convenient, economical and nutritious foods with better shelf-stability. The increase in trends in consumption of ready to eat foods and also reduce post-harvest losses the product was developed. Consumption of fruit and vegetables has been strongly associated with reduced risk of cardiovascular disease, cancer, diabetes, Alzheimer disease, cataracts, and age-related functional decline. Wood apple (*Limonia acidissima* Linn.), commonly known as Bael, is a monotypic genus *Limonia*, native to India and also cultivated in Bangladesh, Pakistan and Sri Lanka (Bakshi *et al.*, 2001) [3]. Fruit is round to oval shape, 5 to 12.5 cm wide, with a woody, amazingly hard rind which is difficult to crack, greyish-white, scurfy rind about six mm thick, pulp brown, mealy, odorous, resinous, astringent, acid or sweetish, with numerous small, white seeds scattered through it. There are two forms, one with large, sweet fruits and the other with small, acidic fruits (Morton and Julia 1987) [2].
Limonia acidissima is well-known for its medicinal properties and has numerous described medicinal uses. Fruits of wood apple are refrigerant, stimulant, astringent, aphrodisiac, diuretic, cardiotonic, tonic to liver and lungs, cures cough, hiccup and good for asthma, constipation, tumours, opthalmia and leucorrhoea (Jadeja *et al.*, 2005) [6]. The abundance of vitamin C (Ascorbic acid) in *Limonia acidissima* L. serves to protect H^+ carrier system and thus helps in tissue oxidation. Antioxidant along with hyaluronic acid maintains capillary tone by keeping the endothelium intact. Along with proline, ascorbic acid enhances collagen synthesis. Ascorbic acid increases Fe^{2+} absorption, which in turn increases Hb formation. Blood loss due to ulceration will be compensated by Hb formation. Vitamin C also initiates the maturation of red and white blood cells (Rao *et al.*, 1998) [23].
Gopalan *et al.*, (2009) [9] reported the nutrient composition of wood apple for moisture 64.2 g, protein 7.1 g, fat 3.7 g, minerals 1.9 g, fibre 5 g, carbohydrates 18.1g, energy 134 Kcal, calcium 130 mg, phosphorus 110 mg, iron 0.48 mg, carotene 61µg, thiamine 0.04 mg, riboflavin 0.17 mg, niacin, 0.8 mg, vitamin C 3 mg. potassium 600 mg, copper 0.21 mg per 100 gms.
Nayak *et al.*, (2012) [13] studied the moisture content in the candy was found to decrease with storage. It decreases from an initial value of about 16% to a final value of about 14% at the end of storage. All the treatments reduced vitamin C content candy. The tannin content of the various aonla candies was statistically significant with respect to aonla varieties. Total soluble solids, acidity, total reducing and browning was found to increase with storage period, while the no reducing sugar was decreased with storage period. On the basis of organoleptic evaluation and biochemical characters concluded that the candy prepared from cv. Krishna and flavored with cardamom powder found to be the best aonla candy. Smidova *et al.*, (2003) [5]

Studied the glassy state and the presence of crystals in hard candies. Hard candies are non- chocolate sweets usually made of sucrose and glucose or of maltose syrup. They can also be made of alditols, used in sugar-free hard candies. In hard candies, carbohydrates or alditols are in amorphous state.

The main objective of the study is to development and standardization of wood apple Katta Meeta (candy), its acceptability and storage stability. To analyze the of developed product- candy (Katta Meeta)

Materials and Methods

Collection of materials

Fruits were collected during the season from the KR market, Bangalore and they were stored in deep freezer for the further study. For the preparation of products other ingredients were procured from local market.

Developement and Standardization of wood apple katta meeta (Candy)

Candy (katta meeta) (WJC)

Four variations of wood apple candy (Katta meeta) WJC) containing different levels of pulp (45, 55, 65 and 75%) were prepared and compared with control (Tamarind) as indicated below. Method used in preparation of candy is given in Plate. 2.

Sensory evaluation

Sensory evaluation wood apple katta meeta (candy) was carried out using 9 point hedonic scale and evaluated by a panel of semi trained panellist (n=20) from PG students UAS Bangalore.

Physicochemical analysis of the wood apple and wood apple katta Meeta (Candy) (Anon, 1980) [1]

Wood apple pulp and wood apple Katta Meeta (candy) were used for the analysis of nutrients namely moisture, protein, fat, ash, crude fibre, calcium, phosphorus, iron and zinc. Carbohydrate content of samples was computed by difference method. Analysis was conducted in triplicates using analytical grade chemicals. Results were expressed on dry weight basis.

Shelf life study

Wood apple products *viz* candies were packed in aluminum foil and store in bottles. The samples of were kept at ambient and refrigerated conditions. Stored product Katta meeta candy was evaluated for sensory attributes (Annexure-III), pH, acidity and microbial load for a period of three months.

Statistical analysis

The following statistical tools were used in the analysis and interpretation of data. The results of chemical parameters of wood apple katta meeta (candy) were analyzed using ANOVA. The responses of subjects were expressed in frequency. The paired‘t’ test was used to test the significance of mean difference between the initial and final values of biochemical parameters.

Results and Discussion

Macronutrient and micronutrient analysis of wood apple pulp

Nutrient content of fresh wood apple pulp is depicted in Table 2. It is evident from the results that wood apple contain moisture (64.63%), protein (6.78), fat (1.38%), crude fibre (5.00%), carbohydrates (20.66%), and total ash (1.55%). Among the minerals phosphorous (110 mg), calcium (122.4 mg) and iron (0.38 mg) were present. Among the vitamins it contains vitamin–C (5 mg).

The proximate analysis of the fruit *L. acidissima* is expressed in percentage (%) was reported by Darsini *et al*., 2013, [10] results revealed that, the protein and available carbohydrate contents were 2.43% and 42.2% respectively. The fruit contains 85% moisture and 29% lipid. However, results also showed that crude fibre and ash content of the fruit was high (11.52% and 8.5%). Gopalan *et al.* (2009) [9] reported the values of wood apple (per 100 g) for carbohydrates (18.1 g) and moisture (64.2 g) which were lower slightly, while the values for protein (7.1 g), fat (3.7 g), ash (1.9 g), energy (134 Kcal), calcium (130 mg) and iron(0.48 mg) were higher. Joshi and Jain (2008) reported lower values for protein (2.2 g), ash (1.3 g) and crude fibre (4 g). The difference in values may be due to different varieties and location of cultivation. According to Pandey *et al.*, 2014, [20] nutrient content of wood apple on dry weight basis was analysed and reporting that, the moisture content was quite low (6.4%) which may be advantageous in view of increasing the sample’s shelf life. Kaitha pulp was found to be very rich in carbohydrates (70.14%). There was an appreciable amount of protein (13.8% by wt) making it a good source of protein, while its fiber content is also good. There is evidence that dietary fiber has a number of beneficial effects related to its indigestibility in the small intestine. Pulp has low amount of fat (4.38%) which makes it an ideal diet for overweight people. The energy value of dried pulp was calculated and the value obtained was 375.18 kcal.

Wood apple pulp was found to contain calcium, magnesium, iron and zinc in high amounts followed by many other beneficial nutrients. A high content of phosphorous can play an important role in bone formation and other essential metabolic activities of the body. Calcium can play a crucial role in providing rigidity to the skeleton besides its involvement in the neuromuscular functions, blood clotting, and many other metabolic processes (Campus *et al*., 2009) [24]. It also contains iron which is used against anaemia, tuberculosis and disorders of growth. Zinc supplementation in diabetes mellitus proved to have antioxidant effect (Roussel *et al*., 2003) [25]. The ascorbic acid content (180 µg/ g of dry matter) would fulfill the recommended dietary allowance (RDA) of National Research Council. It has been reported for its antioxidant and electron donor properties for eight important enzymes in humans.

Adequate intake of dietary fibre can lower the serum cholesterol level, risk of coronary heart disease, hypertension, constipation, diabetes, colon and breast cancer (Rao *et al*., 1998: Ishida *et al*., 2000) [23, 26]. Sodium and potassium take part in ionic balance of the human body maintains and maintains tissue excitability. Na play important role in the transport of metabolites and K is important for its diuretic nature. The ratio of K/Na in any food is important factor in prevention of hypertension and arteriosclerosis, with K depresses and Na enhances blood pressure (Saupi *et al.*, 2009) [22].

Physico-chemical parameters of wood apple

Data presented in Table-3 indicates the physicochemical parameters of wood apple pulp. Total sugars was found to be 3.4%, titrable acidity (3.98%), vitamin C (5%), Total dietary

fibre (28.82%), soluble fibre (1.3%) and insoluble fibre (27.52%), TSS (12.67%) and pH (3.2).

Wood apple contains pulp percentage was 42.9 to 60.6, T.S.S. ranges between 15.0 and 18.4 0Brix, acidity 1.7 to 4.6% and total sugar content varied between 5.1% and 14.3%, reducing sugar 2.6 to 8.8%, vitamin C (2.7 to 13 mg/100g pulp) (Hiwale *et al*., 2008) [7]. Heaqu *et al.*, 2009 [4] reported that the wood apple contains pH (3.1), titrable acidity (4.51), moisture (77.99%), TSS (16), reducing sugar (2.88%), total sugar (11.4g), crude fibre (6.21%), carbohydrates (17.9%), vitamin c(16.4). Titrable acidity (4.16%), pH (3.2), Vitamin-C (2.6%), antioxidant (1412.55µg/g) as reported by Vijaykumar *et al.*, (2013) [17].

Mean sensory scores of wood apple candy (katta meeta)

Results presented in Table-4 (Fig.4) depict that, control group scored higher values for mean sensory attributes compared to treated samples. Among the treated samples CWJC -2 (wood apple 55%) scored higher values for appearance (8.40), texture (8.30), colour (8.45), taste (8.30) and overall acceptability (8.60) compared to other treated samples. WJC-4 (75%) scored lower values of 8.00, 7.80, 8.10, 7.90, 7.95 and 8.00 for appearance, texture, colour, aroma, taste and overall acceptability, respectively. Non-significant difference was observed for all the samples for appearance, texture, colour, aroma and taste whereas there is a significant difference between the treated samples for overall acceptability.

According to Bhuiyan and Easdani 2009 [4], there was static difference in colour among the samples as the P value was 0.0006<0.01. And the p value for flavour. P value for texture and overall acceptablilty was same in candy prepared from unripe bel.

Nutrient composition of katta meeta

Table 5 shows moisture (23.32%), protein (4.20%), fat (1.96%), total ash (0.91%), crude fibre (3.64%), carbohydrates (65.97%) and energy (298%). Srivastav *et al*., 2014 [18], studied that nutritive value of bael candy with flavors. Result revealed that highest energy was found in T2 (310 Kcal) followed by T1 (309 Kcal) and T3 (308Kcal). Protein content was highest in treatment T2 (0.73 g) followed by T1 (0.67 g) and T3 (0.62 g). Nutritive value of bael chutney with flavours result revealed that highest energy was found in T2 (233 Kcal) followed by T1 (231 Kcal) and T3 (230 Kcal). Protein content was highest in treatment T2 (1.38 g) followed by T1 (1.28 g) and T3 (1.27 g). Fat content was highest in treatment T2 (5.42 g) followed by T1 (5.39 g) and T3 (5.39g). Carbohydrate content was highest in treatment T2 (44.61 g) followed by T1 (44.29 g) and T3 (44.17 g). Fiber content was highest in treatment T2 (1.98 g) followed by T1 (1.79 g) and T3 (1.77 g).

Table 6 depicts the calcium (145 mg), Phosphorous (70 mg), iron (0.26 mg), zinc (0.29 mg), copper (0.16 mg) and manganese (0.15 mg). Take and Bhotmange, 2012, [14] studied ber candy was treated with sodium metabisulphite and there were significant changes in chemical constituents of ber candy. Sodium metabisulphite treated candy contains high amount of ascorbic acid (158 mg), crude fibre (12.20%), protein (0.64%) than hot water treated candy. 100 g of candy treated with sodium metabisulphite yields 381.98 Kcal of energy higher than hot water treated candy. Ber candy blanched with hot water contains fewer amounts (132 mg) of ascorbic acid than that of sodium metabisulphite treated candy which may be due to leaching and thermal breakdown of ascorbic acid as it is water soluble and thermally liable.

Physicochemical analysis of wood apple katta meeta stored for 3months

Table 7 depicts the effect of storage on pH and titrable acidity of wood apple products. Significant increase in pH of candy was observed after storing for three months (3.85) whereas titrable acidity decreased from 2.34 to 2.20%. pH increased from 3.73 to 3.74 whereas titrable acidity decreased from 3.48 to 3.45.

Vidhya and Narain, (2010) [27] analyzed nutrient content of wood apple jam and fruit bar and stored under ambient condition for a period of 3 months. Results revealed that the percent reduction in vitamin C content was significant (11.1 to 50.0 percent and 10.5 to 57.8 percent respectively). During the storage of Jam and Fruit Bar upto 90th day the percent loss in Calcium was 15 percent and 12.5 percent respectively. The reduction in phosphorus content of both jam and fruit bar was observed upto 90 days. The reduction in phosphorus content of jam was 5.11 percent during 60th day and 8.80% during 90th day and in fruit bar 5.81 percent during 60th day and 10.7 percent during 90th day of storage. As the period of storage increased the percentage of loss of titrable acidity was also increased in both jam and fruit bar. No changes in TSS, pH, pectin and ash value was observed in the prepared product during storage when compared to the initial observations. The percentage gain in total sugar contents (mg/100 g of sample) was higher in jam followed by fruit bar recording 0.68 and 0.89% respectively. The reducing sugar content (mg/100 g of sample) was higher in jam followed by fruit bar recording 2.59 and 1.53 respectively. With regards to microbial load content of jam and fruit bar, only acceptable amount was observed during 90 day of storage. Hence the prepared wood apple Jam and fruit bar was safe for consumption.

Mean sensory score of stored candy (katta meeta)

Results pertaining to impact of storage on sensory attributes are presented in Table-8. Sensory parameters were significantly affected with temperature and duration. Over all acceptability decreased to 6.35 and 7.5 in ambient and refrigerated conditions. Refrigerated temperature was found better in retaining the sensory parameters. Significant reductions in the average sensory score of all the parameters, stored in ambient conditions were observed. Overall acceptability of candy decreased from 8.6 to 7.75 on 30th day of storage, 6.35 on 90th day of storage. Similar trend was observed in the overall acceptability of candy stored under refrigerated conditions. Colour is an indicator of natural transformation of a fresh food or changes that occur during storage or processing. Similar study was conducted by Priyanka (2014) [21], decrease in the sensory attributes were rapid under the ambient conditions whereas the decrease were slow under refrigerated storage. The results reported were in consistent with the findings of Divya (2010) [11], the appearance, taste, aroma, texture and overall acceptability decreases with storage period for sapota candy. Nayak *et al.*, (2012) [13] reported decrease in overall acceptability of the candies stored under ambient conditions over the period of 270 days. The overall acceptability of the candy prepared from Krishna cultivar increased from 8.3 to 8.5 on 180th day

and then again under refrigerated conditions. JSA showed an increase in the mean score of texture, aroma and overall acceptability on the 45th day under ambient conditions which decreased on 90th day. Acoording to Bhattacherjee *et al*., (2013) [15] reported a decrease in the overall acceptability of the candy stored for 21 days from 7.9 to 4.9 and reported the highest organoleptic score (7.9) for the candies prepared from the fresh fruit followed by anola candy prepared from stored fruits of 7 days. They observe candy scored in overall acceptability was score (4.9) when candy was prepared from 21 days stored fruits. The data indicated that the organoleptic acceptability of the products decreased with the increase in the storage period of fruits in water.

Effect of storage on microbial load of candy

Table 9 shows the microbial load (moulds and yeast) of the best accepted products at initial, 30th day, 60th day and 90th days of storage was estimated by using standard plate count method and results are depicted. Highly accepted WJC-2 (wood apple 55%) was packed in aluminium foil and stored at ambient temperature for microbial analysis. Microbial load of candy is depicted in Table-30. WJC-2 increased the total moulds count (0.33 X 10^4 to 8.33 X 10^4) and yeast (0.33 X 10^4 to 6.00 X 10^4), respectively for 90 days of storage.

Jayashree and Londonkar, (2014) [19] reveals that the different extracts of *F. limonia* against various bacterial and fungal strains indicate that this plant is having potent antibacterial and antifungal effects. The antimicrobial activity of *F. limonia* would be due to the presence of alkaloids, flavonoids and these compounds are most probably soluble in organic polar solvent. According to Senthilkumar and Venkatesalu, (2013) [16] reported that the natural products with dual efficiency in preventing lipid oxidation and antimicrobial properties have incredible potential for extending the shelf life of food products. Among natural products, essential oils of higher plants and their components are gaining interest as food additives and widely accepted by consumers because of their relatively high volatility, ephemeral nature and biodegradability. In that way, essential oil from the fruit pulp of *F. limonia* can be considered as a new and potential source of natural antioxidant and antimicrobial agent.

Table 1: Development and Standardization of wood apple katta meeta (Candy)

Sr. No	Ingredients	Control	WJC-1	WJC-2	WJC-3	WJC-4
1.	Wood apple (g)	-	45	55	65	75
2.	Sugar (g)	51.5	51	41	31	21
3.	Jeera powder (g)	0.87	0.87	0.87	0.87	0.87
4.	Chilli powder (g)	0.5	0.50	0.50	0.50	0.50
5.	Hing powder (g)	0.13	0.13	0.13	0.13	0.13
6.	Salt (g)	2	2	2	2	2
7	Tamarind (g)	45	-	-	-	-
	Total	100	100	100	100	100

Table 2: Nutrient analysis of wood apple pulp (per 100 g)

(a) Proximate (fresh basis)	
Moisture (g)	64.63
Protein (g)	6.78
Fat (g)	1.38
Crude fibre (g)	5.00
Carbohydrates + (g)	20.66
Energy + (Kcal)	122
Ash (g)	1.55
(b) Minerals	
Calcium (mg)	122
Phosphorus (mg)	110
Iron (mg)	0.38
Zinc (mg)	0.50
Copper (mg)	0.25
Manganese (mg)	37.85
Sodium (mg)	0.05
Potassium (mg)	2.64
Manganese(mg)	0.24
(c) Vitamins	
Vitamin C (mg)	5.00

+ Calculated

Table 3: Physicochemical parameters of wood apple fruit

Parameters	Values
Total Sugar (%)	3.40
Titrable acidity (%)	3.98
Total dietary fibre (%)	28.82
Soluble (%)	1.30
Insoluble (%)	27.52
TSS (%)	12.67
pH	3.20

Table 4: Organoleptic evaluation of fruit Candy (katta meeta) (n=20)

	Appearance	Texture	Colour	Aroma	Taste	Overall acceptability
Control	8.65	8.55	8.75	8.40	8.60	8.70
WJC-1(45%)	7.95	8.15	8.30	8.33	8.08	8.04
WJC-2(55%)	8.40	8.30	8.45	8.10	8.30	8.60
WJC-3 (65%)	8.25	8.05	8.25	8.00	8.10	8.35
WJC-4 (75%)	8.00	7.80	8.10	7.90	7.95	8.00
F-value	NS	NS	NS	NS	NS	*
SEm±	0.20	0.19	0.15	0.20	0.20	0.20
CD	0.55	0.53	0.42	0.55	0.56	0.54

* Significant at 5 percent level
NS non-significant at 5% level

Table 5: Macro nutrient composition of katta meeta (per 100g)

Products	Moisture (g)	Protein (g)	Fat (g)	Total Ash (g)	Crude Fibre (g)	Carbohydrates (g)	Energy (g)
Candy (55%)	23.32	4.20	1.96	0.91	3.64	65.97	298

Table 6: Micro nutrient composition of katta meeta (mg per 100g)

Products	Calcium (mg)	Phosphorus (mg)	Iron (mg)	Zinc (mg)	Copper (mg)	Manganese (mg)
Candy	145.00	70.00	0.26	0.29	0.16	0.15

Table 7: Effect of storage on pH and titrable acidity of wood apple katta Meeta (candy)

pH		Titrable acidity	
Duration	Candy	Duration	Candy
Initial	3.83	Initial	2.34
Final	3.85	Final	2.20
Mean	3.84	Mean	2.27
F-value	*	F-value	*
SEM±	0.002	SEm±	0.016
CD at 5%	0.009	CD at 5%	0.062

*Significant at 5% level
NS non-significant

Table 8: Effect of storage conditions on sensory characteristics of candy

Temperature	Duration (days)	Appearance	Texture	Colour	Aroma	Taste	Overall acceptability
Ambient	Initial	8.40	8.30	8.45	8.10	8.30	8.60
	30days	7.85	7.45	7.70	7.50	8.30	7.75
	60 days	7.15	6.6	6.8	6.85	7.40	7.40
	90days	6.05	6.00	6.20	6.05	6.35	6.35
Refrigerated	Initial	8.40	8.3	8.45	8.10	8.30	8.60
	30days	8.45	7.90	8.30	7.80	8.35	8.25
	60 days	8.10	7.75	7.75	7.40	7.70	7.75
	90days	7.35	7.15	7.4	7.35	7.60	7.50
Temperature	F value	**	**	**	**	**	**
	SEm±	0.11	0.07	0.09	0.08	0.08	0.08
	CD @ 5%	0.29	0.20	0.24	0.22	0.22	0.22
Duration	F value	**	**	**	**	**	**
	SEm±	0.15	0.10	0.12	0.12	0.11	0.11
	CD @ 5%	0.41	0.28	0.34	0.32	0.31	0.30
Interaction	F value	*	**	**	**	**	**
	SEm±	0.21	0.15	0.18	0.17	0.16	0.16
	CD @ 5%	0.58	0.40	0.49	0.60	0.43	0.57

*Significant at 5% level
**Significant 1% level
Ns-non significant

Table 9: Effect of storage on microbial load of candy

	Moulds (X 10^4 CFU)	Yeast (X 10^4 CFU)
Initial	0.33	0.33
30th day	3.00	2.33
60th day	5.67	4.33
90th day	8.33	6.00
F-value	*	*
SEM±	0.71	0.41
CD at 5%	2.31	1.33

Plate 1: (A) Wood apple tree (B) Wood apple fruit (C) Wood apple pulp

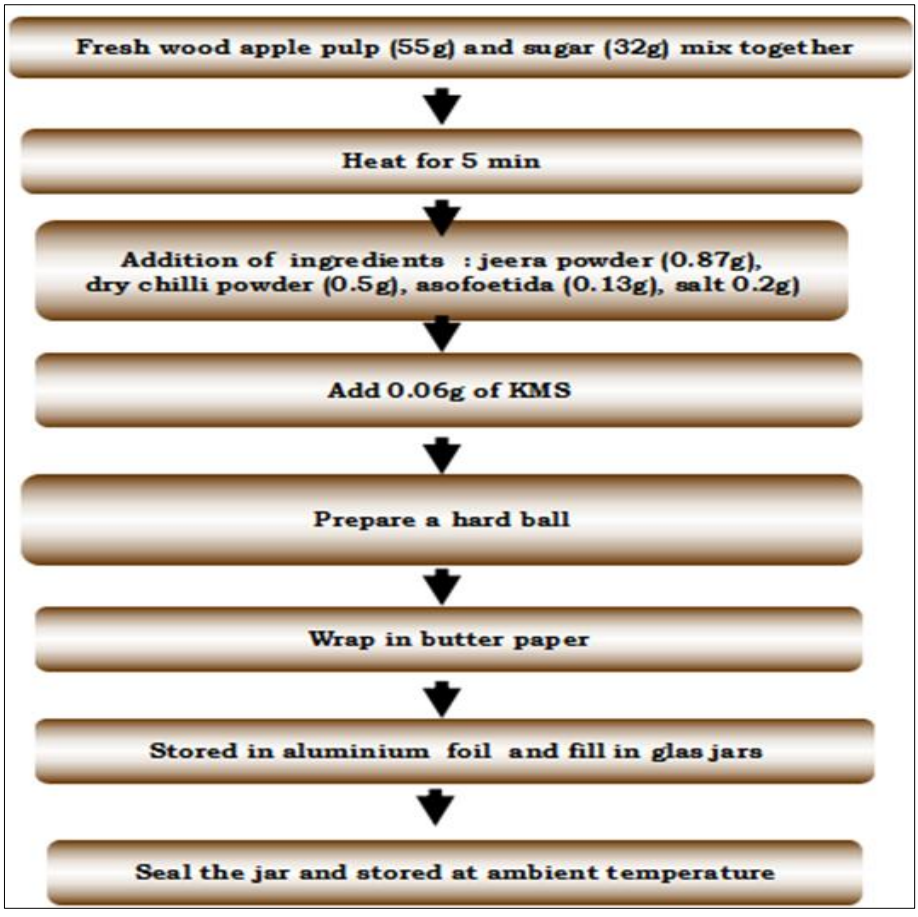

Fig 2: Flowchart for the preparation of candy (Katta meeta)

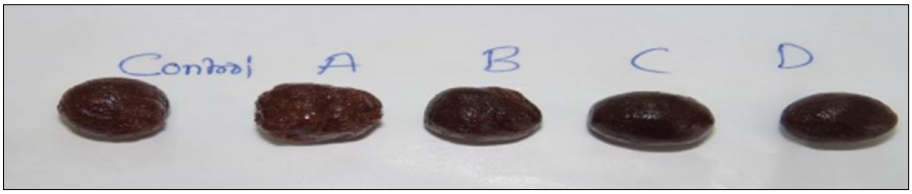

Fig 3: Variation of Katta Meeta

Control
A-WJC-1(45%) B-WJC-2(55%)
C- WJC-3 (65%)
D- WJC-4 (75%)

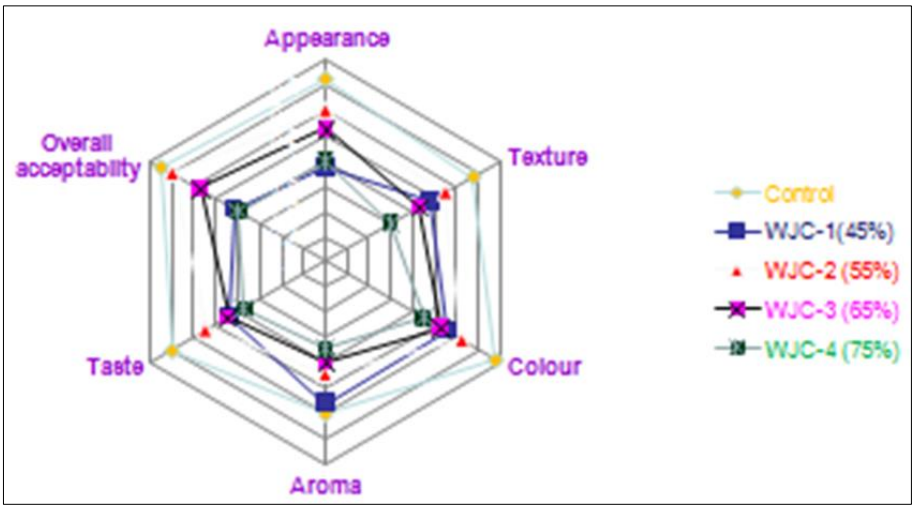

Fig 4: Mean sensory scores of candy

Conclusion

Wood apple is cheap, highly nutritious and seasonably available fruit that can be preserved for human consumption throughout the year. Value added wood apple product developed and standardized and it shows Wood apple katta Meeta (candy) can be stored for more than 3 months at normal and refrigerated temperature. Refrigerated temperature was found better in retaining the sensory parameters. Significant reductions in the average sensory score of all the parameters, stored in ambient conditions were observed.

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Conflict of Interest

Authors declare that we do not have any conflict of interest.

Author (s) contribution statement

Anitha S carried out the analytical work. B.S Reddy was involved planning and drafting of in Sensory analysis and collection of data.

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