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Nutra chemical and Organoleptic Quality Evaluation of Wood Apple Products- an underutilized fruit of North-East India

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ABSTRACT

Wood Apple an underutilized fruit of north-east India was used for finding the feasibility of preparing value added confectionery products such as jam, jelly and candy. The products were prepared from pulp of wood apple with the addition of different combinations of Sugar solution and pectin. The biochemical analysis showed that the Jam (Ja2) with 50% sugar solution has TSS (%) 65.53±0.23, Moisture (%) 40.30±0.24, Ash (%) 0.33±0.02, p^H3.52±0.10, TA0.35±0.04 and TS (%) 54.27±0.23. Jelly (Je1) with 0.5% Pectin was found to be TSS (%) 67.31±0.30, Moisture (%) 28.96±0.05, Ash (%) 0.60±0.01, p^H3.56±0.05, TA 0.33±0.01 and TS (%) 75.77±0.21.Osmotically dehydrated Candy (Ca1) at 40°Brix was found to be TSS (%) 75.08±0.38, Moisture (%) 18.74±0.16, Ash (%) 0.34±0.01, p^H 3.34± 0.22, TA1.34±0.19 and TS (%) 76.12±0.73. Analysis of Variance (ANOVA) and Duncan multiple range tests (for least significance difference among means at $p < 0.05$) showed that the results of Ja2, Je1 and Ca1 were found to be chemically synchronous with the (FSSAI) Food Safety and Standard Authority of India specification. Sensory evaluation of the products on the basis of 5 points hedonic Scale (5 like extremely, 4 like much, 3 Nether like or dislike, 2 dislike moderately, 1dislike extremely) depending on quality attributes of Flavour, colour, taste, mouthful and overall acceptability the Jam and Jelly got highest score and candy got mixed response. The overall result showed that the product was at par with any other such product available in the market. Hence based on the present investigation it can be claimed that wood apple has the potential that can be used for value added products namely fruit candy, jam and jelly.

1. Introduction

Confectioneries are globally demanded and widely accepted products among all age group populations. There is continuous development in finding new technologies and raw materials for enhancing sustainable confectionery production. A combined processing technique of mild heat to gradually high heat, reducing the water activity (a_w) and addition of antimicrobial creates hurdle effect and can make fruit products self-stable for 4-8 months (Alzamora *et al.*, 1993). Hydrostatic pressure can also be used for extracting fruit juices to process various fruit products, it can have greater advantages over traditional technology as it inactivates enzymes and microbes and produces natural healthy nutritious product as it operates at low temperature (Deliza *et al.,* 2005).Non-thermal technology has been rapidly advancing in industry as well as academia for processing high quality fruit products and their value addition(Sharma *et al.*, 2021). It has been observed that various fruits have also been successfully experimented as raw material in producing Jam, Jelly and candy. Fresh cherry can be used to prepare Jam and Jelly and stored for many days at different temperatures (25°C, 35°C and 45°C) with very minimal change in quality attributes (Rababah *et al.*, 2012).Jelly produced with black berry showed good

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acceptance among masses and possesses high marketable potential (de Souza *et al.,* 2014). It can also be prepared successfully from exotic fruit such Dragon fruit (*Hylocereusundatus*) (Islam *et al.*, 2012). Likewise various popular fruits such as banana, pineapple, guava, etc also has great potential in producing such products. Wood apple is a deep rooted evergreen tropical fruit crop. They are commonly found in Indian sub-continent and abundantly available in the north-eastern part of India. They are in use only for domestic consumption, traditional medicines and religious rites. Various studies reveal that it has great potential for commercial cultivation and uses. Almost all parts of the tree are in use and provide great nutraceutical values. The pulp on analysis of with high-performance liquid chromatography and gas chromatography fructose and glucose were found to predominant including linoleic, oleic and vaccenic acid (Lamani *et al.*, 2022).TLC- Cladosporium bioassay showed that the ripe fruit possess antifungal activity due to presence of psoralene, xanthotoxin, 2,6-dimethoxybenzoquinone and osthenol (Adikaram *et al.*, 1989).The seeds of wood apple which is separated and thrown was found to high in unsaturated fatty acid and Gamma-tocopherol that are considered natural antioxidants(Lamani *et al.*, 2021).Even the shell of the fruit can be powdered and made biodegradable (green) materials in composite structures by treating with alkali chemical that possess stronger matrix bonding (Setty *et al.,* 2020). The raw products such as pulp juice have great potential that helps in digestion, curing scurvy, and relieving stomach ailment. It also helps in the mending of ulcerated digestive surfaces and has considerable action against gastrointestinal pathogenic micro-organisms (Bharadwaj and Nadal, 2015).Its nutritional property makes the fruit such a valuable that numerous products can be prepared (including functional foods) and value added to the existing commercial products. It can be processed to prepare various products such as jam, squash, nectar, toffee, slab, powder, ready-to-serve (RTS), wine, etc. that also possess medicinal and various therapeutic values (Singh *et al.*, 2014).The pulp can also be effectively dried used for various purposes (Goyary *et al.*, 2021).

In Jam and Jelly the important gelling agent is pectin. The mechanism of gel formation with the help of natural pectin is complex and depends on various factors such as its quality, type, pH, temperature and the soluble solids (°Brix) content of the pulp and juice. Typically, Jamsare made with fruit pulp andJellies with the extracted clear fruit juice. Jams can be prepared with pulp and juice by adding sugar, pectin and citric acid (Ullikashi *et al.*, 2017)(Rakesh *et al.*, 2005). Jelly can be prepared with different combination of pectin (Islam *et al.*, 2012), as the quality of Jelly depends on the gel formation ability of the pectin. Candy can be prepared by osmotically dehydrating the entire crushed fruit using different combination of sugar syrup and prolong drying (Divya*et al.*, 2014) (Rakesh *et al.*, 2005).

The quality of any processed food product depends upon its characteristic biochemical properties. Those properties can be statistically studied and determine whether the products quality is in synchronous with standard specification. Data can be evaluated by parametric test and assumptions can be validated with normality of errors and homogeneity of residual variance. Analysis of variance is a very robust, powerful and popular tool in statistical inference for comparing products (Silva *et al.*, 2013). Duncan multiple range test can be used to compare the least significance difference among means at $p < 0.05$.A specific attribute of jam, jelly and candy can play an important role in consumer's preference of the product. The best way to understand the consumers' acceptance of the product is to study the degree of satisfaction of the consumer (Kim *et al.*, 2019).This can be done with sensory analysis perceived by primary sense organs in the form of 5 points hedonic Scale (Amerine *et al.*, 1965). By utilizing the scale the consumers can express the score of sample. This magnitude of estimation score for hedonic response can be evaluated and compared between samples or references (Almeida and da Silva, 2002).In this research work Jam, Jelly and Candy was being prepared by standard method and analyzed its nutritional and sensory attributes to untape its potential use.

2. Material and Methods

Fresh fully ripe wood apple was collected from the local area (Assam, India) and all the experimental work was done in the Department of Agricultural Engineering, Assam University Silchar, Assam. The fruit was break into two halves and the pulp scooped out and measured according to the required amount. All the data recorded for calculations were triplicate reading of the experiment.

2.1. Experimental Design and Product Preparation

The different combination of sugar and pectin of Jam, Jelly and Candy are shown in Table 1 and the processing steps are shown below Fig.1. Wood apple fruit pulp was extracted and prepared with different combination of sugar 40%, 50% and 60% and pectin 0.5%, 1% and 1.5%. Three different samples of Ja1, Ja2 and Ja3 were prepared for Jam and Je1, Je2 and Je3 was prepared for Jelly. Candy was prepared by osmotically dehydrating the 100g of pulp in sugar syrup with three different samples Ca1 40°Brix, Ca2 50°Brix and Ca3 60°Brix and prolonged drying solution at constant temperature of 60°C.

Table 1. Different combination of Sugar and Pectin

Jam	Jelly	Candy	Ja1	Je1	Ca1	Ja2	Je2	Ca2	Ja3	Je3	Ca3
Sugar (°Brix)			40			50			60		
Pectin (%)			0.5			1			1.5		

All the products prepared was analyzed in two tier i.e., bio-chemical properties and sensory analysis. For bio-chemical properties the samples were subjected to various tests to verify the product is chemically synchronous with FSSAI specifications. For Sensory analysis five trained panel and forty five untrained/ consumers of age group between 12 years to 70 years (Sugumar and Guha., 2022).The panelist was selected based on the ability to express preliminary sensory test and are able to sense slightest changes in the organoleptic properties(Carpenter *et al.*, 2000).

The panel members were well versed with the sensory analysis process before being inducted. The sensory analysis was done in the morning after 3 hours of breakfast. Each member was made to taste the sample and provide their individual scores in scorecards. The panellist's response was evaluated by Hedonic scale analysis. This analysis was conducted to better understand the organoleptic acceptability and preferability on the sensory attributes that influence the acceptability.

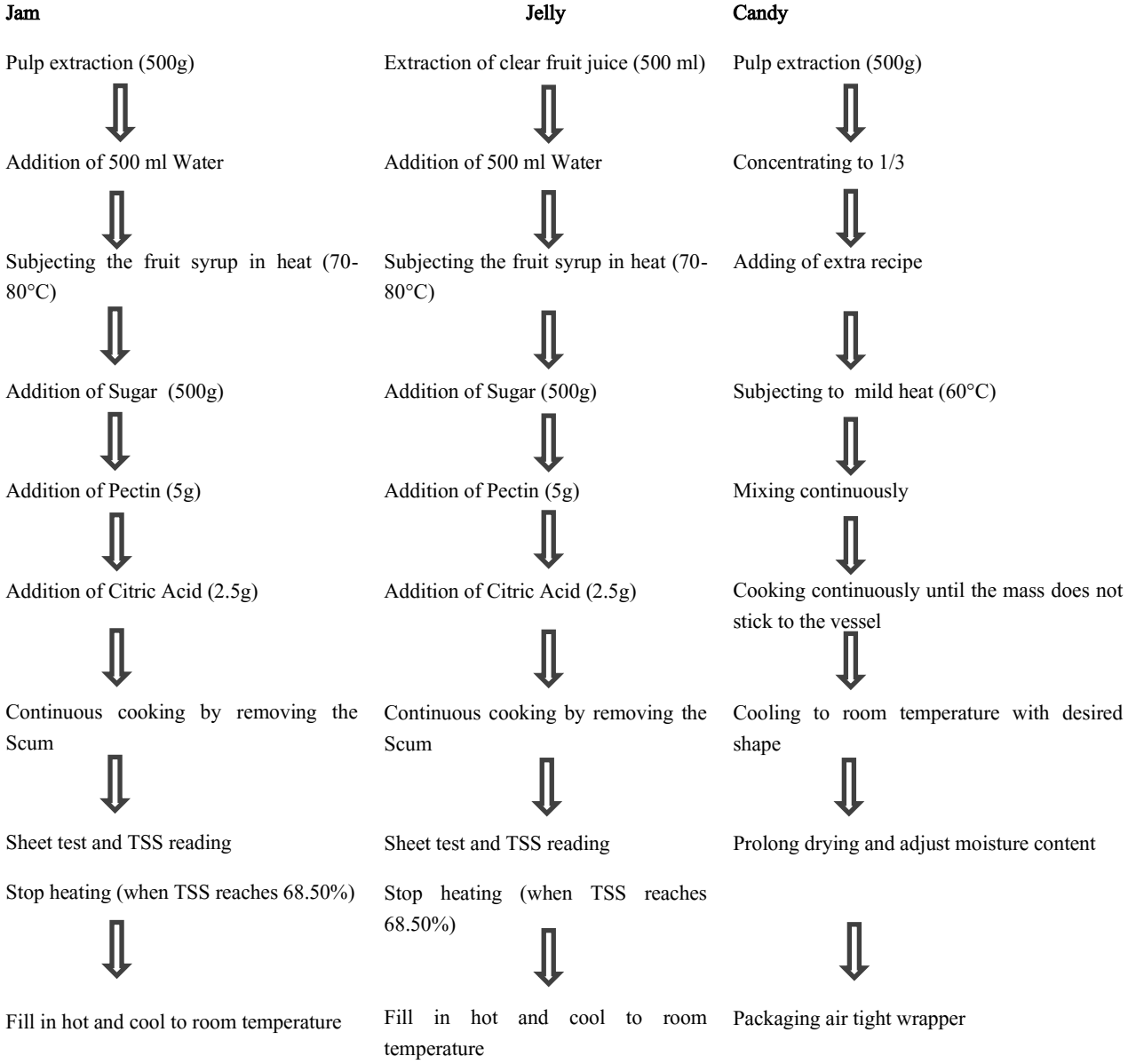

Figure 1. Processing steps of Jam, Jelly and Candy

2.2.T.S.S

Total soluble solids of Jam and Jelly were determined with hand refractometer at room temperature (20°C) (Ranganna., 1986) (AOAC, 2000). The product sample was put on the sample cavity (Prism). The corresponding value of percentage of total soluble solids was directly noted from the reading shown from the eye pitch. In case of candy it was determined by diluting 40g of sample in 100ml of distill water, heated gently by continuous stirring. Few drops were put on the prism and the value of T.S.S. was calculated by the equation 1 (FSSAI Lab. Manual 4. 2015).

$$T.S.S = \frac{P \times M_1}{M_0} \quad \text{.....1}$$

Where; P is the percentage by mass of soluble solids in the diluted solution

M_0 is the mass (g) before dilution

M_1 is the mass (g) of sample after dilution

2.3. Moisture Content

The accurate determination of moisture content of jam, jelly and candy possess a challenge due to their nature (semi-solid and solid). The most common and simple method of AOAC, 1999 was followed to determine the moisture content. It is a thermo-static method where 3 gram of sample was subjected 60°C to dry continuously in Vacuum Oven until three consecutive constant weightsand calculated with the equation 2 provided below. The concept is based on the theory of loss of weight is equal to loss of moisture from the sample irrespective of volatile compounds (Bonner., 1981).

$$\%M = \frac{W_1 - W_2}{W_1} \times 100 \quad \text{.....2}$$

Where; %M is the moisture content percentage on dry basis

W_1 is the initial weight (g) of the product

W_2 is the final weight (g) of the product

2.3. Ash Content

Ash content of jam, jelly and candy signifies its mineral content. It was measured according to AOAC, 1990. In this method 2g of sample was taken in crucible and subjected to 600°C for two hours at muffle furnace. Then the sample was placed in dessicator to be cooled to room temperature and weight taken for calculation as given in equation 3 below (Thiex *et al.*, 2012).

$$\text{Crude Ash } \% = \frac{R - T}{W - T} \times 100 \quad \text{. ....3}$$

Where; T is the empty weight (g) of Crucible

R is the weight (g) of residue with crucible

W is the weight (g) of test sample with crucible

2.4. p^H

The p^H of the jam and jelly was determined with AOAC, 2000 official method no 981.12. Initially the electrode was standardized with buffer solution p^H 7 and p^H 4 then the p^H of the sample was measured. In case of candy 12g of sample was mixed with 8ml buffer with p^H 2 and homogenized for 5 min then the p^H was measured (Yilmaz *et al.*, 2014).

2.5. Titratable Acidity

The Titratable acidity of the products was calculated by standard A.O.A.C. official method 1990. The sample of 5g was homogenized with 20ml distilled water and filter out with filter paper. 5ml of the filtrate was titrated with few drops of phenolphthalein indicator using 0.1 N NaOH (Ranganna., 1986). The percentage acidity was calculated as shown in equation 4 and expressed as percent citric acid.

$$\%\text{Citric acid} = \frac{\text{Titer} \times \text{N of NaOH} \times V \times 64 \times 100}{S \times W \times 1000} \quad \text{.....4}$$

Where; N is the Normality of NaOH

V is the volume (ml) made up

S is the volume (ml) of sample taken for estimation

W is the weight (g) of sample taken

2.6. Total Sugar

Total sugar of the product was estimated by Lane and Eynontitrometric method (AOAC, 1999). From each product 3g of sample (jam, jelly and candy) was into 250 ml volumetric flask. Then the experiment was done as according to the steps provided in AOAC, 1999 official method. Percentage of total sugars was calculated by equation 5 and equation 6 provided below (Ranganna., 1986).

$$\text{mg Total sugar per 100ml} = \frac{\text{Factor} \times 100}{\text{Titre}} \quad \text{.....5}$$

$$\%\text{ Total sugar} = \frac{\text{mg of invert sugar} \times \text{dilution} \times 1000}{\text{Titre} \times \text{wt. or vol. of sample} \times 100} \quad \text{.....6}$$

*Factor was obtained from glucose table (The chemical analysis of food, 7th ed.) (Pearson., 1976).

2.7. Sensory Evaluation

A total of 50 panelists (45 untrained and 5 trained) was selected randomly. The 5-point hedonic scale was provided to them to test and mark the score. The scale was based on: 5 like extremely, 4 like much, 3 Nether like or dislike, 2 dislike moderately, 1dislike extremely. For each sample (jam, jelly and candy) test there was duration of 3 hours gap. The assessors were asked to provide their response for different parameters like color, taste, flavour, mouthful and overall acceptability.

2.8. Statistical Analysis

The analysis of variance was used to examine the level of significance in all parameters. Duncan multiple range test was used to compare the least significance difference among means at $p < 0.05$ (Duncan., 1951). Q value was taken from the table of critical values of Studentized Range distribution (q) for family wise ALPHA=0.05.

3. Results and Discussion

Wood apple fruit has a considerable potential in developing a new and value added products. Different proportions of the pulp in the raw material yields different quality of the product. Jam prepared with the mixture of various herbs and pulp alone also exhibits high hedonic score and sensorial acceptance (Mani and Mitra., 2021). Jelly with 75% water and 25% pulp found to best product with safe and suitable consumption upto 6 months (Kumar and Deen., 2017).Candy prepared with juice of wood apple pulp has qualitatively and organoleptically accepted widely (Mohaptra *et al.,* 2022).The appearance of the product is appetizing. The Plate 1 shows the finished product of Jam, Jelly and Candy.

3.1. Bio-chemical properties

The biochemical properties of the product are most important component in any processed food. It plays a vital role in determining the organoleptic character of food. Table 3 represents the means, standard deviations, and analysis of variance between the biochemical properties of the product. The results showed that there was no significant difference between ($p < 0.05$) bio-chemical properties of the product and hence statistically significant except for moisture of candy and Jam, ash of Jam and candy, p^H of Jam and Jelly and TA of Jam. In case of Jam the Moisture, Ash, p^H and TA are not statistically significant.

Jam

Jelly

Candy

Plate 1 Finished product of Jam, Jelly and Candy

Table 3. Bio-Chemical properties of Jam, Jelly and Candy

	TSS	Moisture	Ash	p^H	TA	TS
Jam						
Ja1	$64.95^{*}\pm$ 0.38	$46.51^{**}\pm$ 0.27	$0.37^{**}\pm$ 0.04	$3.67^{**}\pm$ 0.12	$0.34^{**}\pm$ 0.02	$53.85^{*}\pm$ 0.24
Ja2	$65.53^{*}\pm$0.23	$40.30^{**}\pm$ 0.24	$0.33^{**}\pm$ 0.02	$3.52^{**}\pm$ 0.10	$0.35^{**}\pm$ 0.04	$54.27^{*}\pm$ 0.23
Ja3	$67.18^{*}\pm$ 0.81	$25.98^{**}\pm$ 0.06	$0.34^{**}\pm$ 0.02	$3.53^{**}\pm$ 0.15	$0.33^{**}\pm$ 0.02	$55.04^{*}\pm$ 0.15
Jelly						
Je1	$65.77^{*}\pm$ 0.60	$30.31^{*}\pm$ 0.38	$0.61^{*}\pm$ 0.00	$3.43^{**}\pm$ 0.10	$0.40^{*}\pm$0.03	$74.39^{*}\pm$ 0.53
Je2	$67.31^{*}\pm$ 0.30	$28.96^{*}\pm$ 0.05	$0.60^{*}\pm$ 0.01	$3.56^{**}\pm$ 0.05	$0.33^{*}\pm$ 0.01	$75.77^{*}\pm$ 0.21
Je3	$67.75^{*}\pm$0.17	$29.06^{*}\pm$ 0.13	$0.63^{*}\pm$ 0.01	$3.60^{**}\pm$ 0.08	$0.43^{*}\pm$ 0.02	$76.34^{*}\pm$ 0.15
Candy						
Ca1	$75.08^{*}\pm$ 0.38	$18.74^{**}\pm$ 0.16	$0.34^{**}\pm$ 0.01	$3.34^{*}\pm$ 0.22	$1.34^{*}\pm$ 0.19	$76.12^{*}\pm$0.73
Ca2	$75.58^{*}\pm$ 0.15	$17.58^{**}\pm$ 0.22	$0.36^{**}\pm$ 0.01	$3.74^{*}\pm$ 0.11	$1.08^{*}\pm$ 0.26	$77.31^{*}\pm$ 0.20
Ca3	$76.47^{*}\pm$ 0.16	$16.90^{**}\pm$ 0.14	$0.48^{**}\pm$ 0.00	$3.58^{*}\pm$ 0.07	$1.66^{*}\pm$ 0.11	$77.13^{*}\pm$ 0.20

$\pm$ Value represents standard deviation

Mean values with * superscript within a column are no significantly different ($P < 0.05$).

Mean values with **superscript within a column are significantly different ($P > 0.05$).

According to FSSAI (Food Safety and Standard Authority of India) the Jam must contain- Fruit Pulp 45%, TSS65%, Citric Acid 5% and Preservative (SO2) 40 ppm Jelly Fruit Juice 45%, TSS65%, Citric Acid 2% and Preservative (SO2) 40 ppm and Candy should have Fruit Pulp 55%, TSS 75%, Citric Acid 1 to 1.5%. It was found that the bio-chemical properties of products (Jam, Jelly and Candy) from wood apple have the same properties provided by FSSAI specification prepared from other fruits.

3.2. Sensory Evaluation

The result of hedonic scale rating showed immense pleasing. The majority of the consumer panel as well as expert panel expressed the product extreme liking in all aspects. In case of flavor of the Jam there is a mixed response. The Fig. 2 below shows the sensory analysis of the product.

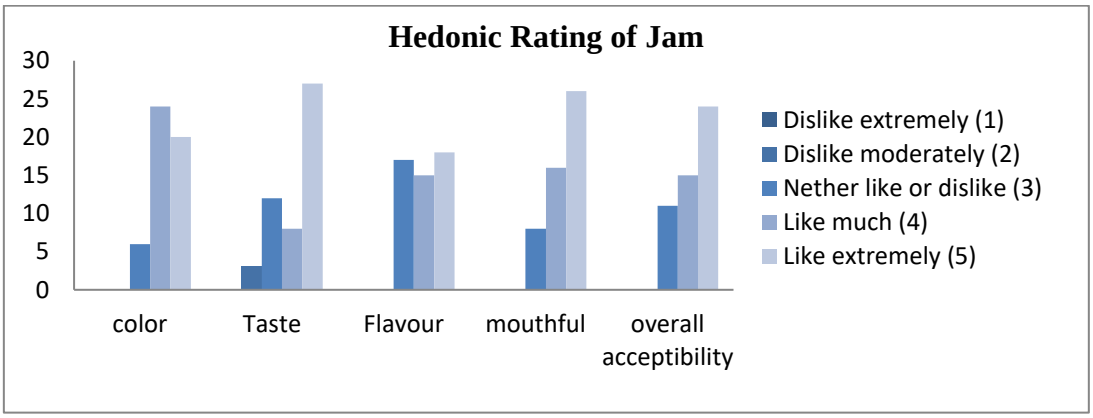

Figure 2. Sensory Evaluation of Jam

In case of Jelly the product is much better liked by the sensory panel. As in this case the panel expressed like extremely in most of the sensory parameters. The Fig. 3 below shows the sensory analysis of the product.

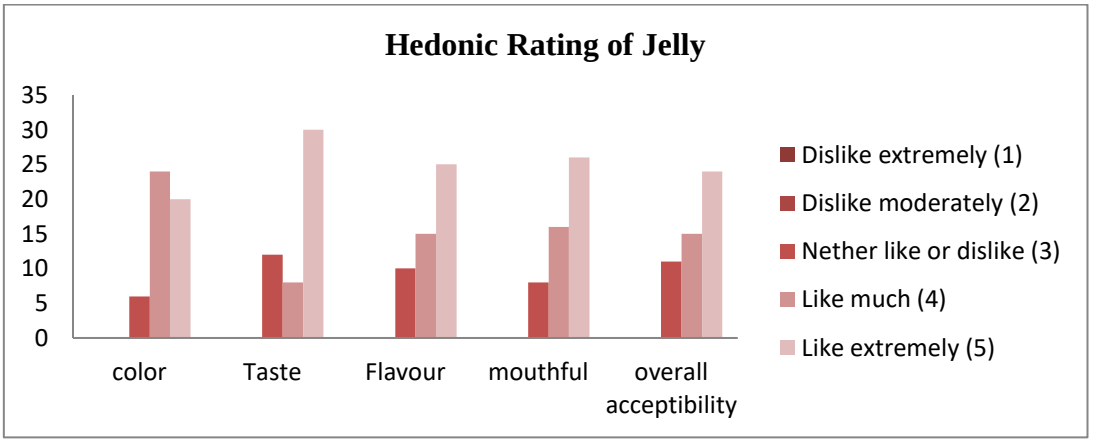

Figure 3. Sensory evaluation of Jelly

The fruit candy got mixed response in majority of the sensory parameters. The panels liked its colour, taste and mouthful but in case of flavor and overall acceptability there were mixed response. There exist some members who even showed dislikingness also. The sensory evaluation of candy is shown in Fig. 4 below.

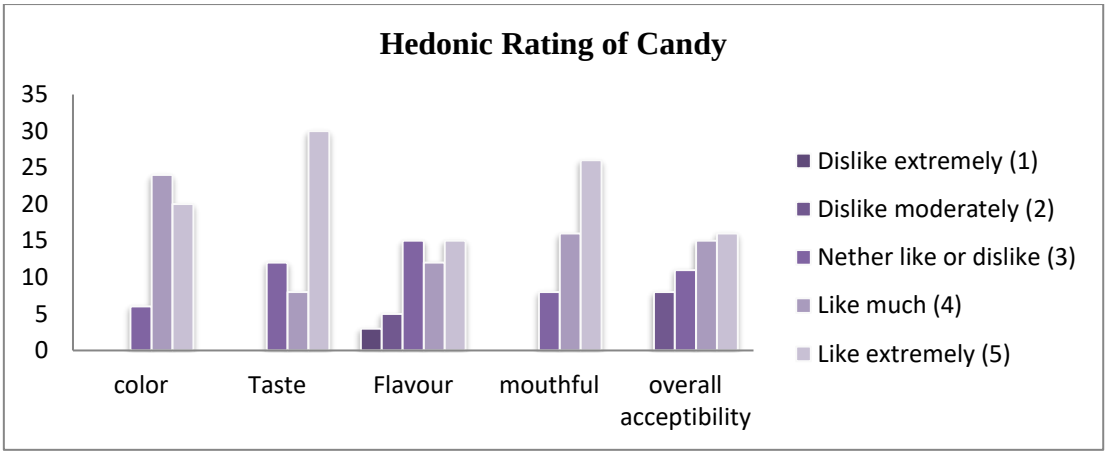

Figure 4. Sensory evaluation of Candy

4. Conclusions

It is evident by this experiment that with the increasing number of consumers of confectionery products and in new product development race the product from wood apple definitely demand its place. Jam (Ja2) with 50% sugar solution, Jelly (Je1) with 0.5% Pectin and osmotically dehydrated Candy (Ca1) at 40°Brix was found to be best product. Analysis of Variance (ANOVA) and Duncan multiple range tests (for least significance difference among means at $p < 0.05$) showed that in bio-chemical properties were synchronous with the (FSSAI) Food Safety and Standard Authority of India specification. Sensory evaluation showed that the confectionery products like Jam, Jelly and Candy can be successfully produced from the pulp of wood apple.

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