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RESEARCH ARTICLE

QUALITY EVALUATION AND STORAGE STUDY OF COCONUT BAR

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ABSTRACT

The study was conducted to develop value added product, coconut bar from coconut. The coconut was collected from local market. Then the coconut was analyzed for their composition. The coconut contains moisture 45.26%, ash 2.76%, protein 4.23%, fat 30.84%, and carbohydrate 16.91%. Total 5 types (C_1= Coconut bar, C_2 = Coconut bar with peanut, C_3= Coconut milk extracted bar, C_4= Coconut bar with sesame, C_5= Coconut bar with egg) of coconut bars with different ingredients were prepared. The C_1 sample contained moisture 12.11%, ash 1.6%, protein 1.62%, fat 3.4%, and carbohydrate 81.25%. The C_2 sample contained moisture 4.81%, ash 1.8%, protein 2.24%, fat 5.2%, and carbohydrate 85.88%. The C_3 sample contained moisture 9.3%, ash 1.5%, protein 0.67%, fat 2.7%, and carbohydrate 85.69%. The C_4 sample contained moisture 9.8%, ash 1.7%, protein 0.53%, fat 4.1%, and carbohydrate 83.74%. The C_5 sample contained moisture 15.04%, ash 1.7%, protein 2.6%, fat 6.6%, and carbohydrate 73.96%. A testing panel consisting 15 panelists studied the acceptability of the samples. The consumer's preferences were measured by statistical analysis of the scores obtained from the response of the panel. Among the samples the C_5 (Coconut bar with egg) sample was awarded the highest score by the panelist.

KEYWORDS

coconut bar, local market, moisture, carbohydrate, consumer's preferences.

1. INTRODUCTION

Coconut (*Cocos nucifera*) is one the most important crops grown in the tropical region and serves as staple food to many populations, such as Asian cultures and Island for centuries. The edible part of the coconut fruit (coconut meat and coconut water) is the endosperm tissue (Lopes and Larkins, 1993). The various products of coconut include coconut oil, tender coconut water, coconut cake, raw kernel, coconut shell, coconut toddy, copra, coconut leaves, wood-based products, coir pith etc. More than 11 million farmers, mostly smallholders with low income, grow the tree in 90 countries (APCC, 2004). It is cultivated for multiple utilities mainly for nutritional and medicinal values. Coconut is grown in more than 18.95 lakh ha in the world with the estimated 16943 million nuts during 2010-11 with an average productivity of 8937 nuts per ha. In the pacific those benefits include food and drink, shade for other crops, land stabilization, weaving, fuel, containers, materials for construction and other uses. Coconut is one of the important nut crops in Bangladesh. Tall type cross-pollinated coconut is widely cultivated in Bangladesh. Its production in Bangladesh is 907255 Metric tons from 12825 acres of land in 2004-2005 (BBS, 2005).

In Bangladesh people suffers from malnutrition problem, coconut-based products can contribute to resolve this as its highly nutritive value. Coconut is highly valued ingredients in our eating practice for its enormous medical benefits. The major importance of the fruit is the coconut water, coconut milk and flesh of the fruit. Coconut water (coconut with liquid endosperm) composed of nitrogenous compounds, inorganic elements, amino acids, organic acids sugars and their vitamins, alcohols ,growth substances (auxins and cytokines) and many other unknown components is the most versatile natural product (Arditti, 2008). Young coconut water is very beneficial for athletes. Nutrients from coconut water are obtained from the seed apoplasm (surrounding cell wall) and are transported symplasmically (through plasmodemata, which is the connection between cytoplasm of adjacent cells) into the endosperm (Patrick and Offler, 2001). Coconut milk has tremendous importance especially in Ayruvedic traditional medicinal purposes. It is generally used to maintain the electrolyte balance and to rule out dehydration losses; also, it is used as treatment for ulcers in the mouth (Nneli and Woyike, 2008).

It's also a saturated fat which has medicinal utilities in the cardiovascular system (Mensink et al., 2008). It has been proven that the coconut oil is much better in composition to saturated fats due to the health risks imposed by the latter (Amarasiri and Dissanayake, 2006). Coconut milk rich in medium chain fatty acids which do not increase cholesterol level in the blood and yet help in body weight maintenance (Kaunitz, 1986). In our country every year huge quantity of coconut is grown in the southern part but the coconut-based product is limited here. Where in the whole world

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coconut-based products have received much attention due to its nutritional and physicochemical properties. Some coconut based popular and value-added products are coconut chips, coconut cream, coconut milk powder, coconut bars, coconut flakes, coconut oil etc. In foreign countries, coconut bars are consumed heavily, because of high nutritive values and appalling. Coconut bars had good sensory acceptance and high purchase intent. Whether, in Bangladesh, there is no specific research on coconut bar and producing industry. With concern of the nutritional value, producing coconut bar will be great value-added product, to create employment locally.

Hence the research was undertaken to produce coconut bar with following specific objectives.

1) To develop value added product coconut bar from coconut kernel
2) To study the chemical and physical properties of the coconut kernel and coconut bar
3) Sensory evaluation and shelf life study of processed coconut bar

2. Materials and Methods

The Research work was performed in the laboratory of Food and Process Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur.

2.1 Materials

2.1.1 Mature Coconuts

The mature coconuts were collected from local market of Dinajpur.

2.1.2 Chemicals, Solvents and Ingredients

Chemicals and reagents used in the study were used from laboratory stock. Sugar, milk powder, hydrogenated fat and other ingredients were collected from local market. Chemicals and solvents used in the study were of analytical reagent grade and water was distilled. Two-layer packages were used as the packaging materials.

2.2 Methods

A number of experiments were carried out in order to accomplish the objectives proposed to achieve the goal of this study. The experiments were divided into some major sections:

a) Collection of coconut.
b) Removal of outer shell
c) Shredded of coconut meat from coconut kernel.
d) Development of coconut bar from coconut kernel.
e) Sensory evaluation of coconut bar.
f) Chemical analyses.

2.2.1 Extraction of Coconut Meat from Coconut Kernel

Collected coconuts were washed by clean water and broken into two halves. A hand coconut scraper was used to collect grated coconut.

2.2.1.1 Flow Diagram of Extraction Coconut Meat

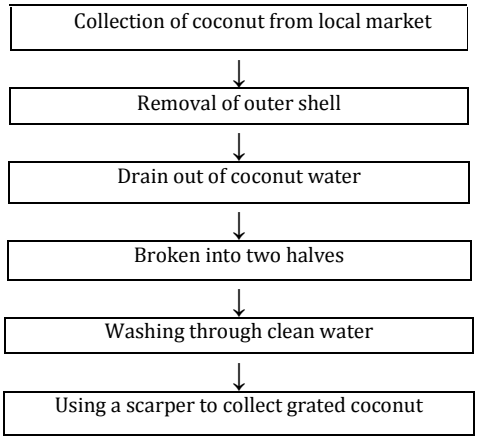


Table 1: Treatments of coconut meat were given below (200g coconut meat)

Sample	Treatment
C_1	Coconut bar
C_2	Coconut bar with peanut
C_3	Coconut milk extracted bar
C_4	Coconut bar with sesame
C_5	Coconut bar with egg

2.2.2 Utilization of coconut meat

The coconut meat was used for developing of coconut bar with different composition. The formulation of bar was outlined as follows as according to Central Food Technology Research Institute, Mysore.

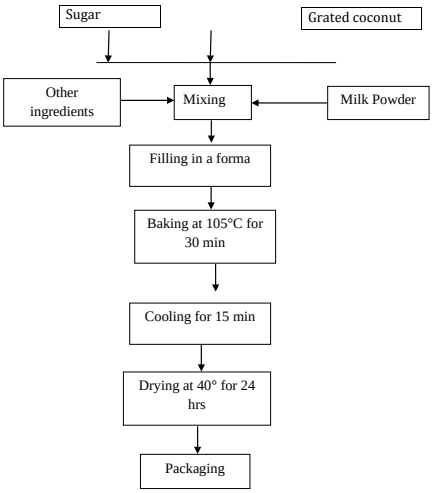
Table 2: Basic formulation of coconut bar on 100 g basis of total ingredient

Ingredients	**C_1**	**C_2**	**C_3**	**C_4**	**C_5**
Coconut meat	53	53	53	53	48
Sugar	30	30	30	30	30
Milk powder	15	10	15	10	10
Hydrogenated fat	2	2	2	2	2
Other Ingredients (egg, sesame, peanut)	0	5	0	5	10
Preservatives	As per required				

2.2.2.1 Procedure for preparation of coconut bar

In the first stage, sugar and grated coconut mixed thoroughly. During this process milk powder, flour and other ingredients (egg, peanut, and sesame) were added. The mixture was continuously stirred with a spoon during mixing. Hydrogenated fat, preservatives and essences were also added. The mixture was filled in a forma of 2 inch length and 1/2 inch thickness and baked for 30 min at 105°C. Then it was cooled for 15 minutes. After this it was dried in cabinet dryer for 24 hours at 40°C temperature.

2.2.2.2 Flow diagram of coconut bar



2.3 Proximate analysis

Proximate chemical composition represents the gross content of important chemical constituents- moisture, protein, fat, ash, total carbohydrate. The study of the proximate composition serves as an important base to study the nutritive quality of coconut bar.

2.3.1 Determination of Moisture content

2.3.1.1 Apparatus

(1) Crucible
(2) Dessicator
(3) Vacuum oven

2.3.1.2 Procedure

Accurately weight about 5 gm of sample in a dish previously was dried and weighed. The material was distributed as evenly as practicable over the

bottom of the dish by gently sidewise movements. Dish was placed in vacuum oven, cover of dish was removed and the material was dried for two hours at 65±1℃ at a pressure not exceeding 50mm of Hg. During heating admit slow current of air into oven. The dish was covered, transferred to dessicator and weighted soon after room temperature is attained. Redried for one hour and the process were repeated till the difference between the two successive weighting is less than 2mg.

$$\%\text{moisture} = \frac{W3 - W2}{W1} \times 100$$

Where,
W_1= Weight of prepared sample taken for test in g
W_2= Weight of empty moisture dish in g
W_3= Weight of (dish+ dried sample) in g

2.3.2 Determination of Ash

Total ash content was determined adopting AOAC method (2004).

2.3.2.1 Procedure

Two gram of each sample was weighed and taken in dry, clean porcelain dishes. Hot air oven method was applied to remove the moisture. Then the samples were burnt on an electrical heater. This was done to avoid the loss of sample in the muffle furnace under higher temperature. Then the samples were transferred into the muffle furnace and burnt at 550^{0}C temperature for 4-6 hours and ignited until light gray ash resulted (or to constant weight). The samples were then cooled in desiccators and weighed. The ash content was expressed as:

$$\%\,\text{ash} = \frac{\text{Weight of residue}}{\text{Weight of sample}} \times 100$$

2.3.3 Determination of Fat

AOAC method (2004) was used to determine crude fat content of the samples.

2.3.3.1 Procedure

The dried sample remaining after moisture determination was transferred into a thimble and plugged the top of the thimble with fat free cotton. The thimble was dropped into the fat extraction tube of a Soxhlet apparatus. The bottom of the extraction tube was attached to a Soxhlet flask. Approximately 75 ml or more of anhydrous ether was poured into the flask. The top of the fat extraction tube was attached to the condenser. The sample was extracted for 16 hr. or longer on a water bath at 70 to 80^{0}C. The water bath was regulated so that the ether which volatilized was condensed and dropped continuously upon the sample without any appreciable loss.

At the end of the extraction period, the thimble was removed from the apparatus and most of the ether was distilled off by allowing it to collect in the Soxhlet tube. The ether was poured off when the tube was nearly full. When the ether was reached to a small volume, it was poured into a small, dry (previously weighed) beaker through a small funnel containing plug cotton. The flask was rinsed and filtered thoroughly using ether. The ether was evaporated on a steam bath at low heat, it was then dried at 100^{0}C for 1 hour, cooled and weighed. The difference in the weights was the ether- soluble material present in the sample. The percent of crude fat was expressed as follows:

$$\%\,\text{Crude fat} = \frac{\text{Weight of the ether - soluble material}}{\text{Weight of sample}} \times 100$$

2.3.4 Determination of protein content

2.3.4.1 Principle

Protein content can be measured by estimating the nitrogen content of the material and then multiplying the nitrogen value by 6.25. This is referred to as crude protein content, since the non-protein (NPN) present in the materials was taken into consideration in the present investigation. The estimation of nitrogen was made by modified Kjeldahl method, which depends on the fact that organic nitrogen, when digested with concentrated sulphuric acid (H_2SO_4) (Rangana, 1977). In the presence of a catalyst, is converted into ammonium sulphate $(NH_4)_2SO_4$. Alkali is added to the sample to convert ammonium (NH_4^+) to ammonia (NH_3). The ammonia is steam distilled into a receiver flask containing boric acid and titrated with a standard acid solution. This determines % of N that is multiplied by 6.25 to give the value of crude protein.

2.3.4.2 Digestion Mixture

Potassium sulphate (K_2SO_4) and dehydrated copper sulphate ($CuSO_4.5H_2O$) in a ratio of 5g: 1g were powdered with mortar and pestle and mixed well. Concentrated HCl was used for titration.

2.3.4.3 Sodium hydroxide (40%)

Sodium hydroxide (NaOH) 40 gm was dissolved in distilled water and the volume was made up to 100 ml.

2.3.4.4 Receiver Solution

10g of boric acid was added in 500 ml deionized water in a one liter volumetric flask, heated it gently until the boric acid was dissolved. An amount of 0.02 g bromo cresol green was dissolved with 4 ml ethanol (C_2H_5OH) in a separate beaker. An amount of 0.014g methyl red was dissolved with 4 ml ethanol (C_2H_5OH) in another beaker. Some bromocresol green and methyl red solution mixture was then transferred into that volumetric flask and 0.5 ml 1N NaOH was added when the total volume was made 1000 ml with deionized water.

2.3.4.5 Procedure

The Kjeldahl method consists of the following steps:

a) Digestion of the sample
b) Distillation
c) Titration

2.3.4.6 Digestion of the sample

The sample (10g) was taken in weighing paper and measured accurately. This sample was poured into a 100 ml clean and dry Kjeldahl flask, to which 10 gm of Digestion Mixture and 25 ml of concentrated HCl were added. To avoid frothing and bumping 2-5 glass beads was placed inside the flask. A blank was carried with all reagents except sample material for the comparison. The flask was then heated in a Fume hood Digestion chamber at 400˚C until the solution became colorless. At the end of digestion period, the flasks were cooled and diluted with 100 ml distilled water. A small piece of litmus paper was placed in the solution and the reaction was found to be acidic.

2.3.4.7 Distillation

The distilling set of Kjeldahl apparatus was thoroughly washed with distilled water before starting the distillation. In a measuring cylinder 60 ml of 40% NaOH was taken and it was carefully poured down the side of the Kjeldahl flask. The mouth of the flask was closed with a stopper containing connective tube, which was ultimately connected to the ammonia-receiving flask containing 25 ml receiver solution.

The mixture was boiled at such a rate that water and ammonia distilled over at a steady moderate rate. The heating was not too slow so that the receiver solution might be sucked into the Kjeldahl flask and not to fast so that the distilling ammonia did not escape the receiver solution without absorption.

2.3.4.8 Titration

The ammonia absorbed in the receiving flask containing receiver solution was titrated with 0.1 N HCl. Similarly, a reagent blank was distilled and titrated. Protein content of the sample on the percentage basis was calculated by the following formula:

$$\%\,\text{of protein (g)} = \frac{(c-b) \times 14 \times d \times 6.25}{a} \times 100$$

Where,

a = sample weight (g)

b = volume of the sodium hydroxide required for the back titration

c = volume of sodium hydroxide required for the back and to neutralize 20 ml of 0.1 N H_2SO_4 (for blank)

d = Normality of NaOH used for titration.

The conversion factor of nitrogen to protein is 6.25 and atomic weight of nitrogen is 14.

2.3.5 Determination of Total Carbohydrate

The total carbohydrate content of the samples was determined as total carbohydrate by difference, which is by subtracting the measured moisture, ash, fat and protein from 100 (Pearson, 1976).

2.4 Sensory evaluation of Coconut Bar

The sensory evaluation of five types of coconut bars were evaluated for color, flavor, taste, texture and overall acceptability parameters by 15 tasters. The panelists were selected from the teachers, students and employees of the Faculty of Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur. For evaluation coconut bars were given to 15 panelist and randomly coded sample. They were asked to rate the given sample a 9 point hedonic scale with ratings of: 9 =Like extremely, 8 = Like very much, 7 = Like moderately, 6 = Like slightly, 5 = Neither like or unlike, 4 =Dislike slightly, 3 =Dislike moderately, 2 = Dislike very much, 1 = Dislike extremely. The results were evaluated by Analysis of Variance and Duncan's Multiple Range Test (DMRT) procedures of Statistical Analysis System (SAS, 1985).

2.5 Statistical Analysis

Data were analyzed using Statistical Analysis System (SAS, 1985) a single factor analysis of variance was carried out. Significant difference was estimated using Duncan's Multiple Range Tests (DMRT). Differences were considered to be significant at ≤ 0.05.

2.6 Storage studies of Coconut Bar

Processed Coconut bar was stored both room temperature (21-32°C) and refrigeration temperature (3°C),with double layer high density polythene coated with aluminum foil, shelf life of coconut bar was assessed by objective and subjective tests at different time intervals. The moisture content, color, flavor, texture, fungal growth was observed initially for 3 month.

3. Results and Discussion

After collecting the coconut sample from the local market, coconut bar was prepared. The samples were analyzed in our laboratory and nutritional quality was determined for each sample. Moreover, sensory evaluation or panel taste was performed for each sample also. The results are discussed in this chapter.

3.1 Proximate Composition of Fresh Coconut at Different Stage of Maturity

The fresh coconuts at different stage of maturity were analyzed for their physicochemical composition and the results are presented below.

Table 3: Compositions of fresh coconut at different stage of maturity

Composition	Immature Stage (wb)	Matured Stage (wb)
Moisture (%)	50.16	45.26
Ash (%)	3.14	2.76
Fat (%)	26.67	30.84
Protein (%)	6.58	4.23
Carbohydrate (CHO) (%)	13.45	16.91

The Table 3 showed that the fresh coconut at immature stage contained 50.16% moisture, 6.58% protein, 26.67% fat, 3.14% ash, 13.45% CHO. Also the matured stage coconut contained 45.26% moisture, 4.23 % protein, 30.84% fat, 2.76% ash and CHO 16.91 %. The composition of immature stage and matured stage coconut under this study more or less agree with those reported by Laureles (2000) was 4.10% protein, 11.2% carbohydrate, 28.93% fat, moisture 54.69 % and ash 1.02 %. This is attributed to several factors such as location and varietal differences as well as age of the nuts, time of the year the nuts are harvested, age of copra before expelling.

3.2 Analysis of Coconut Bar

The nutritional composition of coconut bar was resulted in the following table 4.

Table 4: Composition of coconut bar

Sample	Moisture	Protein	Ash	Fat	Totoal Carbohydrate
C_1	12.11±.06	1.62±.08	1.6±.06	3.4±.07	81.25±.13
C_2	4.81±.16	2.24±.08	1.8±.02	5.2±.02	85.88±.25
C_3	9.3±.01	.67±.08	1.5±.02	2.7±.03	85.69±.13
C_4	9.8±.03	.53±.08	1.7±.02	4.1±.02	83.74±.09
C_5	15.04±.03	2.6±.27	1.7±.04	6.6±.02	73.96±.31

Where,
C_1 = Coconut bar
C_2 = Coconut bar with peanut
C_3= Coconut milk extracted bar
C_4=Coconut bar with sesame
C_5=Coconut bar with egg

3.2.1 Moisture content

Moisture content is one of the important parameters which interfere in the quality of the bars during the storage. The moisture content of coconut bar were found 12.11%, 4.81%, 9.3%, 9.8% and 15.04% respectively shown in table 4. The moisture content of the samples is different with one another. The highest moisture content is found in sample C_5 where the lowest moisture is found in C_2. This is due to use different ingredients such as egg, peanut and sesame. The founding results are almost similar to who reported that the moisture content of banana fruit bar in the range of 13 to14% (Mathur et al., 1972). This value is almost similar to the present study. But the moisture content of papaya and tomato bar in the ranged of 27.1 to 28% (Ahmad et al., 2005). The reported moisture content of papaya and tomato bar found the highest values than the present study.

3.2.2 Protein content

The protein content of developed bars found 1.62%, 2.24%, 0.67 %, 0.53% and 2.63 % respectively, shown in table 4. Sample C_5 contained the highest protein than others. The protein values of C_2 sample almost similar to C_5. But C_4 & C_3 samples contained low protein level. C_5 sample found the highest protein % because of egg treatment. On the other hand, sample C_2 focused the almost similar because of peanut treatment. A study reported the protein of apple and banana pulp fruit bar supplemented with omega-3 fatty acid samples of different treatments found the values in the range of 1.37 to 1.42% (Parimata and Puneet, 2015). The values found differences with the present study because of different treatment and samples were also different.

3.2.3 Ash content

the ash content of the coconut bars were found the values of 1.60%, 1.86%, 1.51%, 1.78% and 1.75% shown in table 4, where C_2 samples focused the highest ash content rather than others. Besides C_4 and C_5 samples obtained almost similar ash content. C_2 sample contained highest ash content because of peanut addition. C_3 sample contained lowest ash content because of extraction of milk from coconut meat. Present study found all values of ash content lower than 3.99%.

3.2.4 Fat content

From the data on fat test of coconut bar supplemented with peanut, milk ,sesame and egg samples of different treatments and control found the highest mean fat percentage in sample C_5 (6.6) followed by C_2 (5.2), C_4 (4.1) , C_1 (3.4) and C_3 (2.7) shown in table 4. Highest score obtained for C_5 because of addition of egg and the lowest score for C_3 because of addition of extraction of milk from coconut.

3.2.5 Total carbohydrate

The total carbohydrate content of the present study found the values 81.25, 85.88, 85.69, 83.74, 73.96 respectively, table 4. The highest carbohydrate content was found in sample C_2 and C_3 (85.88 and 85.69). A group researchers reported that total carbohydrate content on fortified Sapota-Papaya Fruit Bar remain in range of 77.94 to 78.14%, which is similar to sample C_5 (Take et al., 2012).

3.3 Sensory Evaluation

Sensory evaluation of the Coconut bars were carried out on the color, flavor, texture and taste by a panel of fifteen members from the faculty of engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur. The bars were evaluated by the panel members in ascending order of 9 point hedonic scale with the ratings of: 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 and 1 = Dislike extremely. The panel members scored showing their degree of preference of the different Coconut bars.

The results were evaluated with Analysis of Variance (ANOVA) and Duncan's Multiple Range Test (DMRT) procedures of the Statistical Analysis System. The responses were tabulated in tables (Appendix). The mean scores for color, flavor, texture and taste of five types of coconut bars are shown in table 5. The mean score for color, flavor, texture and taste of the Coconut bars are presented details in appendix.

3.3.1 Sensory evaluation of coconut bar

The sensory characteristics of coconut bar was showed in table 5

Table 5: Sensory Evaluation of coconut bar

Sample	Colour	Flavour	Texture	Taste
C1	6.6 ± 0.81^{c}	7.6 ± 0.82^{a}	7.2 ± 0.94^{b}	7.4 ± 0.63^{a}
C2	5.8 ± 1.06^{d}	5.9 ± 1.09^{b}	6.0 ± 1.13^{c}	5.7 ± 0.88^{b}
C3	7.4 ± 1.12^{b}	6.1 ± 0.91^{b}	6.6 ± 1.35^{bc}	6.2 ± 1.03^{b}
C4	5.9 ± 1.03^{d}	5.8 ± 1.06^{b}	6.1 ± 1.06^{c}	6.1 ± 0.83^{b}
C5	8.1 ± 0.64^{a}	8 ± 0.79^{a}	8.13 ± 0.83^{a}	8.0 ± 0.75^{a}

Values are mean ± SEM of fifteen replicates a-b. The test values along the same column carrying different superscripts for each composition content are significantly different ($p < 0.05$).

3.3.2 Color

The color of coconut bar was recorded highest value of 8.1 for its very good color of C_5 sample. Even though C_3 and C_1 samples scored the lower values (7.4 and 6.6), but recorded like good color as that of C_5. On the other hand C_2 and C_4 recorded lowest value of 5.8 and 5.9 respectively. Although all samples are moderately good but statistically C_5 is highly significantly different from others. On the other hand C_2 sample found the lowest color score due to addition of sesame However scores for all this bars were within quite acceptable. Factors may have affected the color by addition of sesame and peanut. Low color ratings of bar food can decrease the acceptability as color is important organoleptic attribute which enhanced product acceptability.

3.3.3 Flavor

In case of flavor preference of analysis of variance ANOVA (Appendix A.4 and A.5) showed that there was a significant difference ($P<0.005$) in flavor acceptability among the bars. But there was no significant difference between C_1 and C_5. On the other hand C_2, C_3, C_5 has significance difference among others bars that shown in table 5. C_4 gained score 5.9 that lower than other bars which may be affected for addition of sesame. Due to addition of egg C_5 got highest score (AOAC, 2004). Ingredients such as pectin, honey, sugars, egg, nuts, salt and other fruit, added to improve the flavor and color can also influence the texture quality of the final product. Flavor is important attribute in case of bar products for consumer acceptability otherwise the acceptability of bar product is refused if it is odor.

3.3.4 Texture

The texture score of the Coconut bar found in the range of 6 to 8.1 from table 5. From the above result C_5 sample found the highest score due to binding capacity of egg and longer drying. Higher temperature and longer drying times are associated with lower moisture content and harder texture. From table 5 we also concluded that C_1 and C_5 samples were found significant differences from other samples.

3.3.5 Taste

The taste acceptability of the different bars ranged from (5.7 – 8). There was a significant difference among the bars that showed in table 5. The highest taste was found for C_5 in the range of 8, on the other hand the lowest score was obtained for sample C_2 from table 5. The highest score for C_5 because of egg addition compared to others and the lowest score for C_2 sample due to the absent of value-added ingredients like egg, sesame and peanut. Addition of ingredients is also known to have a significant impact on papaya and guava fruit leather as studied (Biswas, 2013). From our statistical analysis we also concluded that C_5 sample found significant difference then other samples.

3.4 Storage studies of coconut bar

The moisture absorption and moisture removal are the two important parameters required to be studied for all types of dried and high-sugar products in order to assess shelf life of the finished products

3.4.1 *Effect of storage time and temperature on the moisture content of coconut* bars

This study was conducted to assess the effect of storage time (60 days) on room temperature (21-32°C) and refrigeration temperature (3°C), packaged by double layer high density polythene coated with aluminum foil, on the basis of moisture content of coconut bar samples C_1, C_2, C_3, C_4, C_5. As can be seen from Figure 1 that the initial moisture content of mixed fruit bar were 12.11 (C_1), 4.81 (C_2), 9.3 (C_3), 9.8 (C_4), 15.04 (C_5). The moisture content of coconut bars at ambient temperature (21-32°C) was slightly increased (Figure 1) due to environmental humidification and water vapor permeability of double layer high density polythene.

Similarly, the moisture content of coconut bars at refrigeration temperature (3°C) was slightly increased (Figure 2). In this case the increasing of moisture content dependent on refrigeration humidity and water vapor permeability of double layer high density polythene. A study reported wood apple bar moisture content was increased in wood apple bar during storage (Vidhya et al., 2011). Similar trend was noted in the present study.

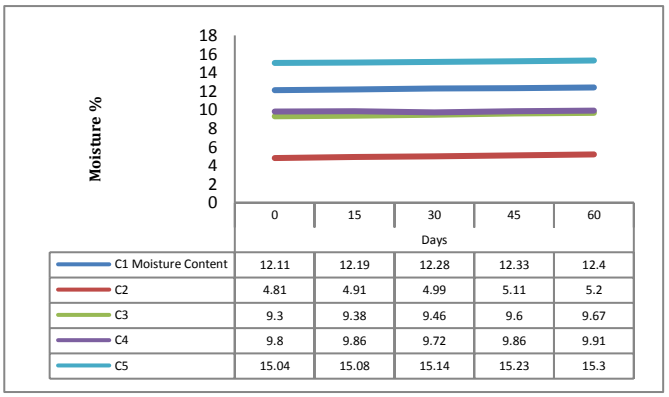


Figure 1: Effect of storage time and temperature on the moisture content of coconut bar samples in double layer density polyethylene coated with aluminum foil at 21 to 32°C temperature

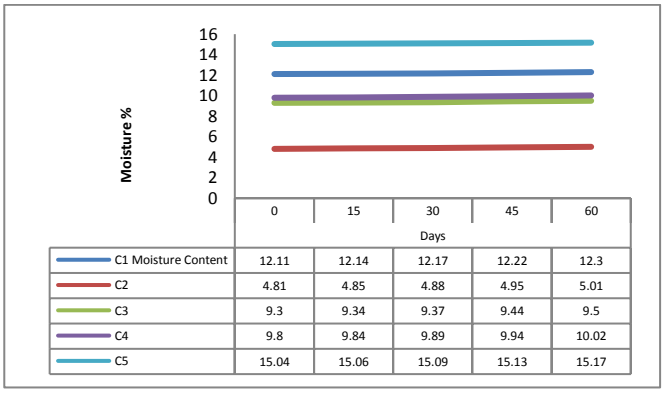


Figure 2: Effect of storage time and temperature on the moisture content of coconut bar samples in double layer density polyethylene coated with aluminum foil at 3°C temperature.

3.5 Organoleptic studie

Table 6: Visual observation of coconut bars in double layer high density polyethylene with Time

Storage temperature	Storage time	Color	Flavour	Texture	Fungal growth	Remarks
Room temperature (21 to 32) °C	0	White	Pleasant	Firm	Not visible	Good
	15	White	Pleasant	Firm	Not visible	Good
	30	White	Pleasant	Firm	Not visible	Good
	45	White	Pleasant	Firm	Not visible	Good
	60	Slightly brown	Pleasant	Loose	Not visible	Good
Refrigerated Temperature (3-4°C)	0	White	Pleasant	Firm	Not visible	Good
	15	White	Pleasant	Firm	Not visible	Good
	30	White	Pleasant	Firm	Not visible	Good
	45	White	Pleasant	Firm	Not visible	Good
	60	Slightly brown	Pleasant	Firm	Not visible	Good

No remarkable changes were found in texture, color and flavor in total storage period. Samples stored in high density polythene package showed loose texture and slightly brown color after 60 days of storage at ambient temperature (21-32°C). Fungal growth was not visible in both storage conditions. Similar types of observations have been recorded during storage of papaya bar and during storage of mango guava sheet (Aruna et al., 1999; Hemakar et al., 2000).

3.6 Cost analysis

In this case the experiment was done with coconut of which the cost of raw material was analyzed for selected sample C_5. The cost analysis of sample production from coconut is shown in table 7.

Table 7: Cost of 10 coconut bar of selected sample C_5 (250gm) with Fixed Cost and Break-Even Point

No	Particulars	Amount in TK.	
[A]	**Sales or market price of coconut (250 gm)**		150
[B]	**Variable cost**		89.5
	Coconut	30	
	Sugar	7.5	
	KMS(preservative)	1.0	
	Egg	8.0	
	Milk powder	15.0	
	Essence(vanilla)	2.0	
	Dalda	1.0	
	Electricity	10.0	
	Labour	10.0	
	Packaging	5.0	
[C]	**Contribution[A]-[B]**	150-89.5	60.5
[D]	Total Fixed Cost(40% of total cost)		35.8
[E]	**Total cost[B]+[D]**		125.3
	Profit[A]-[E]	150-125.3	24.7
[P]	**Break-Even Point[D]/[C]**	35.8/60.5	59.17%

The cost of 10 coconut bar of selected sample (250) is TK 150. But the cost per coconut bar will be lower when it was produced in large scale. The cost of production of coconut bar depends on market value of raw material, proper management and depending on the fixed cost.

4. Summary and Conclusion

The present experiment was performed with aim to evaluate the physico-chemical properties of coconut bar supplemented with peanut, sesame and egg to analyze the sensory and storage duration of coconut bar and to estimate the cost of the coconut bar. As regards the organoleptic qualities, of all the fruit bars processed was excellent followed by Nutritional quality particularly protein, fat, total carbohydrate and ash content. From the study of five treatments applied to the samples it may be concluded that the samples of treatment C_5 (coconut bar with egg) was found the best in every aspect of organoleptic analysis, i.e., color and appearance, flavor and taste, body & texture. It was found that the treatment C_5 was best in the physio-chemical analysis as well as storage studies. Therefore, it may be concluded that, there is a great scope of manufacturing Coconut bar using egg as it is proved to have nutritional properties as well as health benefits and it is good for all age group people.

Every year in Bangladesh a large amount of coconut is spoiled due to inadequate processing and preservation facilities. The fruit bar preparation is a simple technique for preservation and suitable for cottage and small-scale enterprises. Inadequate processing and preservation facilities for such fruit are responsible for increasing post-harvest losses of these commodities. Proper utilization and value addition of these important fruits through preparation of fruit bars may help to encourage development of cottage and small-scale industries in the country.

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APPENDIX I

Table A.1: Rating score for color of coconut bar.

No. of Panelists	Sample C1	Sample C2	Sample C3	Sample C4	Sample C5
1	7	5	9	6	8
2	5	7	9	6	9
3	7	5	6	5	8
4	7	6	7	7	8
5	8	6	6	7	9
6	7	6	7	5	7
7	6	5	7	4	8
8	6	4	7	7	9
9	6	4	6	5	8
10	7	7	9	7	8
11	8	7	9	7	8
12	6	6	8	6	7
13	7	7	7	7	8
14	6	7	7	6	9
15	7	6	7	5	8
Total	100	88	111	90	122
Mean	6.6	5.8	7.4	6	8.13

Hedonic scale used: 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.

Table A.2: ANOVA (Analysis of variance) for color of Coconut bar

Sources of variance	Degree of Freedom	Sum of squares	Mean square	F-value
				Calculated
Sample	4	56.667	14.167	15.658
Errors	70	63.333	.905	
Total	74	120		

Table A.3: DMRT (Duncan's Multiple Range test) test for color of coconut bar

Types of the Sample	Original order of means	Types of sample	Ranked order of means
C1	6.6^{c}	C1	8.1^{a}
C2	5.8^{d}	C2	7.4^{b}
C3	7.4^{b}	C3	6.6^{c}
C4	5.9^{d}	C4	5.9^{d}
C5	8.1^{a}	C5	5.8^{d}

Table A.4: Rating score for flavor of coconut bar.

No. of Panelists	Sample C1	Sample C2	Sample C3	Sample C4	Sample C5
1	7	6	7	5	8
2	7	4	7	7	7
3	6	6	6	7	8
4	9	4	4	6	9
5	7	7	6	7	8
6	8	5	7	5	8
7	8	7	5	6	8
8	7	6	7	4	8
9	9	6	6	4	9
10	7	6	6	7	7
11	8	6	6	6	9
12	8	7	7	6	7
13	8	6	5	6	7
14	7	8	7	5	9
15	8	5	6	7	9
Total	114	89	92	88	121
Mean	7.6	5.9	6.1	5.8	8.06

Hedonic scale used: 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.

Table A.5: ANOVA (Analysis of variance) for flavor of Coconut bar

Sources of Variance	Degree of Freedom	Sum of squares	Mean square	F-value
				Calculated
Sample	4	64.187	16.047	17.849
Errors	70	62.933	.899	
Total	74	127.120		

Table A.6: DMRT (Duncan's Multiple Range test) test for flavor of coconut bar

Types of the Sample	Original order of means	Types of sample	Ranked order of means
C1	7.6^{a}	C1	8^{a}
C2	5.9^{b}	C2	7.6^{a}
C3	6.1^{b}	C3	6.1^{b}
C4	5.8^{b}	C4	5.9^{b}
C5	8^{a}	C5	5.8^{b}

Table A.7: Rating score for texture of Coconut Bar

No. of Panelists	Sample C1	Sample C2	Sample C3	Sample C4	Sample C5
1	8	7	9	7	9
2	7	7	6	5	9
3	8	6	9	6	8
4	7	6	7	6	7
5	8	4	5	7	9
6	7	7	5	6	9
7	5	4	6	4	7
8	6	6	8	5	8
9	7	5	7	8	8
10	8	7	7	7	9
11	8	7	7	6	8
12	8	7	7	7	7
13	6	7	5	6	8
14	8	5	5	7	9
15	7	5	6	5	7
Total	108	90	99	92	122
Mean	7.2	6	6.6	6.13	8.13

Hedonic scale used: 9 = like extremely; 8 = like very much; 7 = like moderately; 6 = like slightly; 5 = neither like nor dislike; 4 = dislike slightly; 3 = dislikemoderately; 2 = dislike very much; 1 = dislike extremely.

Table A.8: ANOVA (Analysis of variance) for texture of Coconut Bar

Sources of variance	Degree of Freedom	Sum of squares	Mean square	F-value
				Calculated
Sample	4	45.920	11.480	9.864
Errors	70	81.467	1.164	
Total	74	127.347		

Table A.9: DMRT (Duncan's Multiple Range test) test for texture of Coconut Bar

Types of the Sample	Original order of means	Types of sample	Ranked order of means
C1	7.2^{b}	C1	8.13^{a}
C2	6.0^{c}	C2	7.2^{b}
C3	6.6^{bc}	C3	6.6^{bc}
C4	6.1^{c}	C4	6.1^{c}
C5	8.13^{a}	C5	6.0^{c}

Table A.10: Rating score for taste of Coconut bar.

No. of Panelists	Sample C1	Sample C2	Sample C3	Sample C4	Sample C5
1	6	6	7	5	8
2	7	5	4	6	8
3	7	6	6	7	8
4	8	6	7	6	8
5	8	4	7	5	8
6	8	5	8	7	9
7	8	7	6	7	9
8	7	5	6	5	8
9	7	5	6	6	7
10	7	6	5	6	7
11	7	5	6	7	9
12	8	7	7	7	7
13	8	6	5	5	7
14	7	7	7	6	8
15	8	6	7	7	9
Total	111	86	94	92	120
Mean	7.4	5.7	6.26	6.13	8

Hedonic scale used: 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.

Table A.11: ANOVA (Analysis of variance) for taste of Coconut Bar

Sources of Variance	Degree of Freedom	Sum of squares	Mean square	F-value
				Calculated
Sample	4	54.347	13.587	19.331
Errors	70	49.200	.703	
Total	74	103.547		

Table A.12: DMRT (Duncan's Multiple Range test) test for taste of Coconut Bar

Types of the Sample	Original order of means	Types of sample	Ranked order of means
C1	7.4^{a}	C1	8.0^{a}
C2	5.7^{b}	C2	7.4^{a}
C3	6.2^{b}	C3	6.2^{b}
C4	6.1^{b}	C4	6.1^{b}
C5	8.0^{a}	C5	5.7^{b}