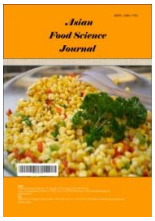

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Evaluation of Margarine Quality Prepared from Sunflower and Coconut Oil

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Authors' contributions

This work was carried out in collaboration among all authors. Author MAT designed and performed the study, managed the literature searches, wrote the protocol and wrote the first draft of the manuscript. Author MRA performed and managed the statistical analysis of the study. Author MAA supervised the study. All authors read and approved the final manuscript.

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ABSTRACT

The study was conducted to prepare healthy and nutritious margarine from sunflower oil (SO) and coconut oil (CO). Quality evaluation of the prepared margarine samples were done by determining the nutritional value and sensory evaluation. Three samples of margarine were formulated from sunflower oil and coconut oil on a 100 gram basis. The average composition of margarine was found as follows: 84% fat, 10.5% moisture, 4.75% protein and 0.58% total carbohydrate. The three formulations are: A (sunflower oil: coconut oil=1:1), B (sunflower oil: coconut oil=3:2), C (sunflower oil: coconut oil=2:3). The three formulations were analyzed for chemical composition. A sensory evaluation of the processed margarine was also done with the help of 10 panelists on the basis of organoleptic properties such as color, flavor, taste and overall acceptability. Both the statistical analysis and proximate analysis (moisture, fat, protein, total carbohydrate and ash content comparison) showed that formulation B (sunflower oil: coconut oil=3:2) is more acceptable than other formulations. So, it may be concluded that by processing margarine (sample B) in Bangladesh, it will be helpful for both vegetarian and general people to consume butter like nutritious product and to fulfil the daily intake of fat per capita to ensure good health.

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Keywords: Margarine; sunflower oil; coconut oil; nutritional value; sensory evaluation.

ABBREVIATIONS

SO : Sunflower Oil
CO : Coconut Oil
HDL : High Density Lipoprotein
LDL : Low Density Lipoprotein
FA : Fatty Acid
PUFA : Poly Unsaturated Fatty Acid
AR grade : Analytical Reagent grade

1. INTRODUCTION

Fats and oils, along with carbohydrates and proteins are major components of the human diet. Fats provide energy and essential fatty acids that are required for proper growth and development [1]. The Food and Agriculture Organization (FAO) and the World Health Organization (WHO) have recommended an average daily intake of 55 g-fat per capita to compliment the requirement for energy [2] and a 20-30% conversion rate for fat to energy to ensure good health [3].

Margarine is a non-dairy product created by hydrogenation used for spreading, baking, and cooking. Hipolyte Mege-Mouries created it in France, in 1869 as a substitute for butter [4]. Whereas butter is made from the butterfat of milk, modern margarine is made mainly of refined vegetable oil and water, and may also contain milk. Margarine, like butter, consists of a water-in-oil emulsion containing at least 80% fat and 16% water in maximum [5]. Butter contains about 70-75% of saturated fatty acids. Therefore it can increase cardiovascular disease [6]. The current facts are that butter does contain more saturated fat than margarine and that butter also contains cholesterol while margarine does not [7, 8]. They suggest that butter and margarine have roughly the same number of calories. Still, health officials suggest that since both butter and margarine are fat, they should be used sparingly [9]. Low degree of hydrogenated margarine is better than higher degree because of the trans fatty acids which can raise LDL cholesterol and lower HDL cholesterol in humans [10,11].

Sunflower oil (*Helianthus annuus* L.) is an excellent source of healthy unsaturated fats, protein, fiber and essential nutrients such as vitamin E, the B-complex vitamins, copper, zinc, folate, iron, and phytochemicals and tastes much lighter than other vegetable oil [12,13]. According to the National Sunflower Association [14], sunflower oil contains both mono-unsaturated and polyunsaturated fats and is lower in saturated fat, making it a healthy cooking choice. Sunflower oil composition consists of 90% oleic and 10% linoleic acids or vice versa [15]. Energy value of sunflower oil which contains saturated fatty acids - 4.7 kJ/g, monounsaturated fatty acids - 14.6 kJ/g, polyunsaturated fatty acids - 32.6 kJ/g, omega-3 polyunsaturated fatty acids - 0.1 kJ/g and omega-6 polyunsaturated fatty acids - 32.5 kJ/g [16].

Coconut oil (*Cocos nucifera*) has generated discussions about its possible effects on health, especially for being an oil rich in saturated fat [17]. Unlike other vegetable oils, coconut oil is chemically very stable and not easily oxidized. It is very resistant to free radical attack and in combination with other oils, acts as an antioxidant, helping to prevent the oxidation of other oils. Most of the FAs in CO are composed by medium chain; thus, they are directly absorbed by the intestine and sent to the liver to be used as an energy source [18]. The main fatty acids (FA) found in CO are the lauric (12:0), myristic (14:0) and palmitic (16:0) acids, which represent 46%, 17% and 9% of the FA, respectively [19]. On the other hand, CO contains high level of lauric acid that is directly absorbed by enterocytes and may prevent the fat deposition in blood vessels. Furthermore, the amount of cholesterol present in this oil is very small: 0.012 mg of dietary cholesterol for each 85 g of CO [20]. That's why, the study was undertaken to prepare margarine using sunflower oil and coconut oil and also to analyze the quality of the margarine on the basis of chemical composition and sensory evaluation.

2. MATERIALS AND METHODS

The study was conducted in the laboratory of the department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh, Bangladesh.

2.1 Materials

Edible oils of sunflower and coconut, egg, liquid milk, lemon were collected from the local market of Mymensingh, Bangladesh. All the other chemicals and solvents with AR grade were used from laboratory stocks.

2.2 Preparation of Margarine

At first, sunflower oil & coconut oil taken in a pot. Below the pot ice cube was kept to make the mixture cool enough to frost. Then using homogenizer we homogenized the mixture. After that we added skim milk powder (16.25% of total amount of oil), sugar (0.28%), egg yolk (4.5%), salt (0.75%) and lemon juice (3.75%) in the mixture to mix it thoroughly and then cooled and crystallization were done. After that, rolling and kneading were done and kept at freezer for further consumption of the prepared margarine [19]. The Table 1 represents the amount of sunflower oil and coconut oil quantity (as per 100%) formulation by indicating A, B and C (Fig. 1) [21]. We prepared margarine using of these formulations and then performed proximate analysis and sensory evaluation.

2.3 Determination of Fat Content in Margarine

Fat content was determined by adopting the method given by Ranganna [22]. One gram sample of margarine was transferred to 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°C to 80°C. The water bath was regulated so that the ether which volatilized was condensed and dropped continually 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 reached 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 22 filtered thoroughly, using ether. The ether was evaporated on a steam bath at low heat, it was then dried at 100°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:

$$\% \text{ Crude Fat} = \frac{\text{Weight of ether} - \text{Soluble materials}}{\text{Weight of sample}} \times 100$$

Table 1. Amount of sunflower oil and coconut oil in three formulations

Formulation	% of sunflower oil	% of coconut oil
A	50	50
B	60	40
C	40	60

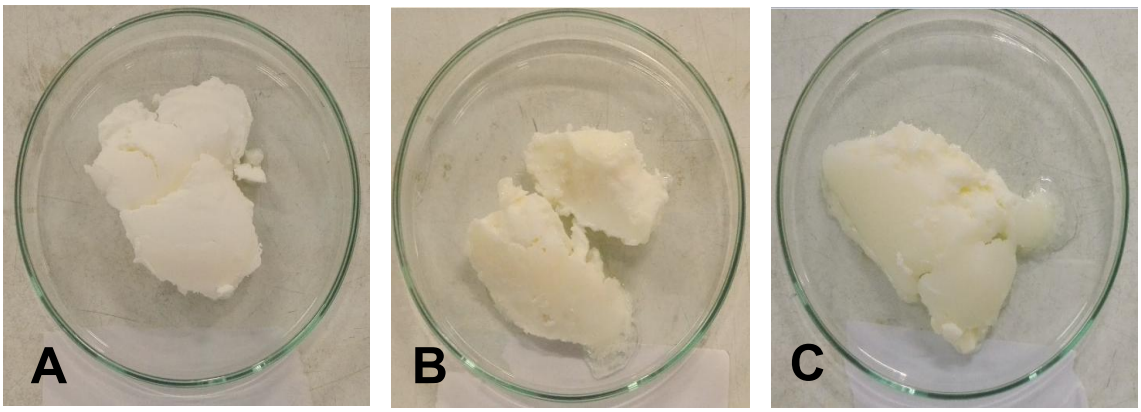

Fig. 1. Formulation A = (sunflower oil: coconut oil=1:1); B = (sunflower oil: coconut oil=3:2); C = (sunflower oil: coconut oil=2:3)

2.4 Determination of Protein Content

Protein content was determined as per Ranganna [22]. The accepted method was as follows:

For estimation of protein, the steps were followed:

2.4.1 Digestion

5 g sample, 2 g of digestion mixture and 25 ml concentrated sulfuric acid was taken in a kjeldahl digestion flask. It was heated for 4 hours in a kjeldahl digestion and distillation apparatus. If the color of the substance is pale yellow the digestion is complete.

2.4.2 Distillation

After digestion 100 ml water, 100 ml 40% NaOH and glass blitz were added in the kjeldahl flask which containing about 10 ml 2% boric acid and 2-3 drops mixed indicator. About 100 ml distillate was collected just before the distillation was stopped the receiving flask was moved so that the tip of the distilling tube was out the distillate. Some distillate was collected in this way to make sure the condenser tube was free from traces of ammonia.

2.4.3 Titration

The ammonia collected was titrated with 0.1N HCl solution and titre value was recorded.

2.4.4 Calculation

Percentage of nitrogen and protein were calculated by the following equation:

$$\%\ N_2 = \frac{(T_s - T_b) \times \text{Normality of HCl} \times 14}{\text{Weight of sample} \times 1000} \times 100$$

Where,

T_s=Titre volume of the sample (ml), T_b= Titre volume of the blank (ml), % Protein = Nitrogen × 6.25*

2.5 Determination of Moisture Content

Moisture content was determined adopting the method of AOAC [23]. Initially, weight of previously dried (1 hr at 100ºC) empty crucible with cover was taken and 5 g of sample was placed on it. Then the crucible was placed in an air oven and dried for 16-24 hours. After drying, the crucibles were removed from the oven and cooled in desiccators. The crucibles were removed from the desiccators and weighed soon after reaching room temperature. Drying cooling and weighing were accepted until two consecutive weights do not vary more than 3 mg. The losses in weight were taken as the moisture loss of the samples. From these weights the percentage of moisture content in food sample was calculated as follows:

$$\%\ \text{Moisture} = \frac{\text{Loss of weight}}{\text{Weight of sample}} \times 100 = \frac{\text{IW} - \text{FW}}{\text{IW}} \times 100$$

Where,

IW=Initial weight of samples, FW=Final weight of samples.

2.6 Determination of Ash Content

Ash was determined by the following methods of AOAC [23].

2.6.1 Procedure

The oven dried sample was taken in crucible and weighed. Then transferred the sample into a muffle furnace and burn for about 6 hours at a temperature of about 550^0C. After burning, the crucible was cooled in a desiccators and weight was taken. Then % of ash content was determined.

2.6.2 Calculation

$$\%\ \text{Ash content} = \frac{W2}{W3} \times 100$$

Where,

W_2 = initial weight of dry matter
W_3= weight of ash

2.7 Determination of Total Carbohydrate

Carbohydrate content of the samples was determined as total carbohydrate by difference that is by subtracting the measured protein, fat, ash and moisture from 100 [24].

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Margarine

The fat content of sunflower oil and coconut oil is about 100%. The margarine was made by various ratio of sunflower oil and coconut oil to assess the quality evaluation. The percentage of the oil content was expressed on the basis of 100 g. The average fat content of the developed sample is about 84%. The chemical composition of the developed samples are given in Table 2.

3.2 Moisture Content

The moisture content of three different formulations of margarine were determined [23]. From the statistical analysis (Fig. 2), it was observed that formulation B had less moisture content than others. The margarine which contains less moisture content is acceptable [5].

3.3 Fat Content

The fat content of three different formulations of margarine were determined [22]. The fat content was given in Fig. 3. From the statistical analysis, it was observed that formulation B had less fat content than others. The margarine which contains less fat content is acceptable [5].

3.4 Protein Content

The protein content of three different formulations of margarine were determined [22]. The fat content was given in Fig. 4. From the statistical analysis, it was observed that formulation B had more protein content than others. The margarine which contains more protein content is acceptable. So, it can be said that formulation B was more acceptable.

3.5 Ash Content

The ash content of three different formulations of margarine were determined [23]. The fat content was given in Fig. 5. From the statistical analysis, it was observed that formulation B had more ash content than others. The margarine which contains more ash content is acceptable.

3.6 Total Carbohydrate Content

The fat content of three different formulation of margarine was determined [24]. The fat content was given in Fig. 6. From the statistical analysis, it was observed that formulation B had more carbohydrate content than others. The margarine which contain more carbohydrate content is acceptable. So, the formulation B was more acceptable than others.

Table 2. Chemical composition of margarine

Component	Formulations		
	A	B	C
Fat	83.82	83.55	84.1
Moisture	10.68	10.45	10.8
Protein	4.75	5.05	4.35
Total carbohydrate	0.57	0.683	0.51
Ash	0.18	0.267	0.24

Formulation A = (sunflower oil: coconut oil=1:1); B = (sunflower oil: coconut oil=3:2); C = (sunflower oil: coconut oil=1:1)

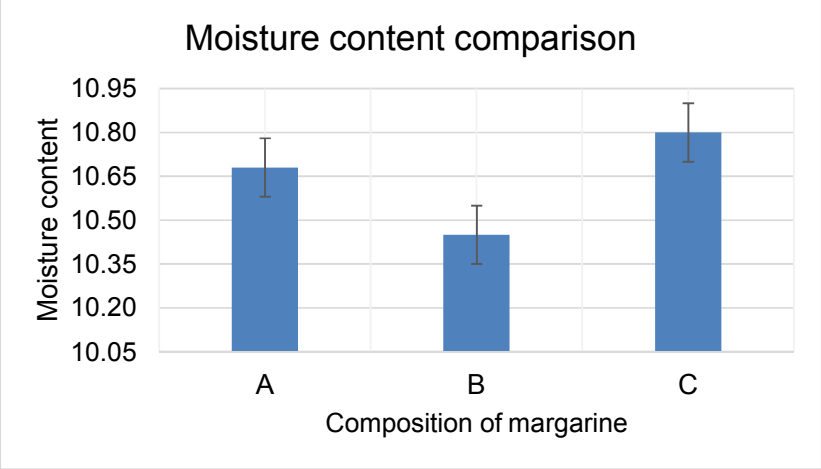

Fig. 2. Moisture content comparison of three formulated margarine

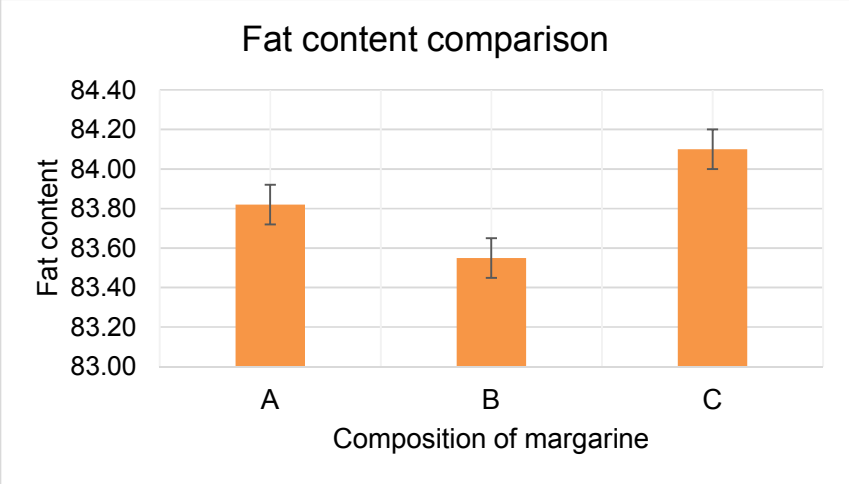

Fig. 3. Fat content comparison of three formulated margarine

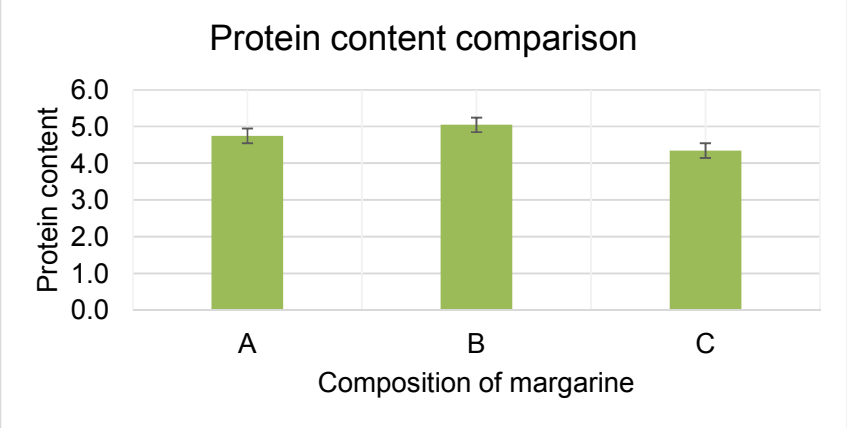

Fig. 4. Protein content comparison of three formulated margarine

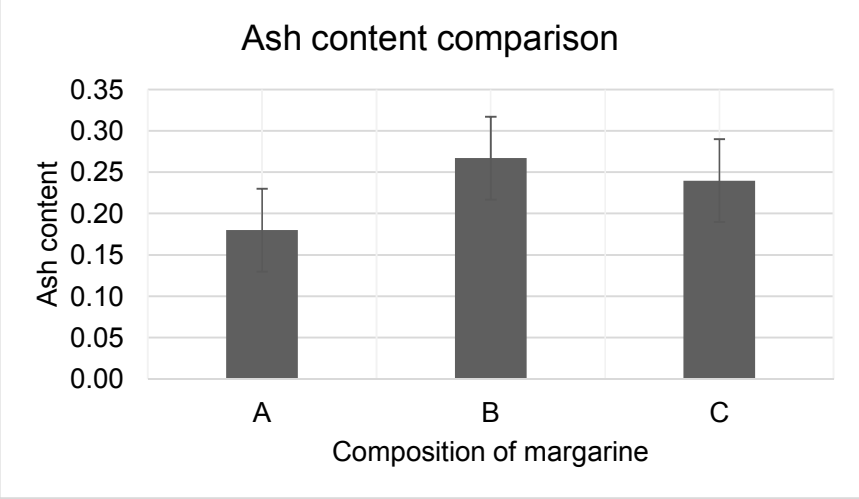

Fig. 5. Ash content comparison of three formulated margarine

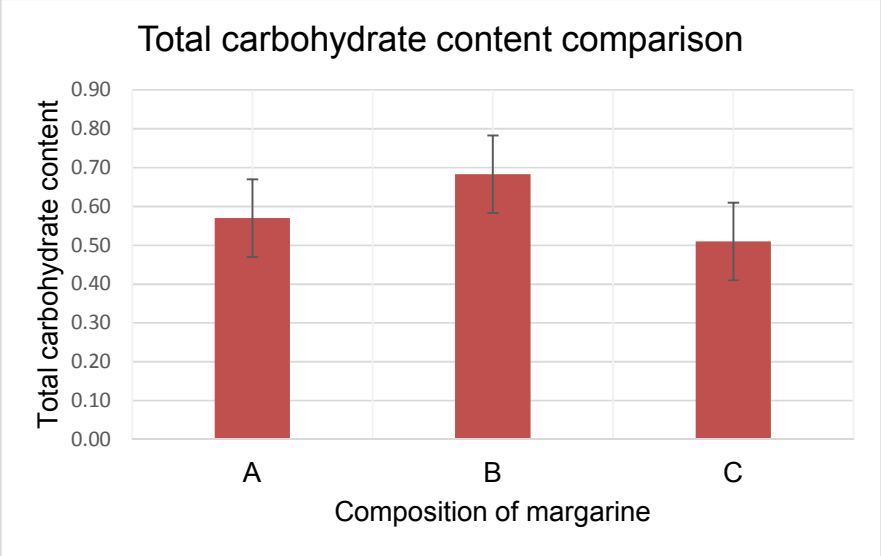

Fig. 6. Total carbohydrate content comparison of three formulated margarine

Table 3. Mean sensory score of margarines

Formulations	Sensory attributes			
	Color	Flavor	Taste	Overall acceptability
A	7.3[a]	5.8[b]	6.2[a]	6.9[ab]
B	7.4[a]	7.1[a]	6.9[a]	7.1[a]
C	6.2[b]	5.4[c]	5.5[c]	5.9[c]
LSD value (p<0.05)	0.72764	0.87014	0.89183	0. 72764

3.7 Statistical Sensory Evaluation of Margarine

The color, flavor, taste and overall acceptability of margarines were evaluated by 10 panelists. The mean scores for color, flavor, taste and overall acceptability preference are presented in Table 3. One-way analysis of variance (ANOVA) was used and mean comparison was performed by Duncan's new multiple range test. A one way analysis of variance and Least Significant Difference (LSD) test showed that there is significant difference at α = 5% in the color of all samples i.e., the samples were not equally accepted. From the statistical analysis shown in Table 3, it can be said that formulation B was obtained higher value in all of the attributes (color, flavor, taste and overall acceptability) than the formulation A and C. So, it can be concluded that the formulation B is more acceptable than others.

4. CONCLUSION

The study was undertaken to prepare margarine from sunflower oil and coconut oil for having their many health benefits. After the development of margarine from three formulations, both proximate analysis and sensory evaluation were done to assess which one is the best among them. Based on the analysis, we came to a conclusion that formulation B is more acceptable than formulation A and C. By processing formulation B, it will be helpful for vegetarian to consume butter like product. Further investigation is necessary for commercial exploitation in our country.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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