The Pharma Innovation Journal 2023; 12(10): 2560-2565

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(10): 2560-2565

www.thepharmajournal.com
Received: 18-07-2023
Accepted: 23-08-2023

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Studies on utilization of kokum butter in chocolate making

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Abstract
Kokum butter is a by-product of kokum fruit and has a potential to replace the cocoa butter in chocolate making. In recent, days due to lower production of cocoa beans the price of cocoa butter has been increasing. Economically viable kokum butter can be a good substitute for cocoa butter in chocolate making which has the similar properties as that of cocoa butter. This experiment presents the utilization of kokum butter in chocolate making. The chocolates have been prepared by using kokum butter in different percentage by volume *viz* 5%, 10%, 15%, 25% and 50%. The best result has been obtained in 25% by volume of kokum butter. This chocolate is further examined to obtain the physiochemical properties and same has been compared with locally available chocolate in the market. In addition, the cost estimation of the chocolate has been done.

Keywords: Kokum butter, cocoa butter, chocolate, physiochemical properties, cost estimation

Introduction

Kokum (*Garcinia indica*) fruit is a significant minor fruit in the Guttiferance family (Kureel *et al*. 2009) [4]. In the Kokan, Goa, South Karnataka, and Kerala regions of the Western Ghats, kokum is a plant that is extensively grown in tropical rain forests (Kureel *et al*. 2009) [4]. It is a sparely used tree known in English as 'Wild Mangosteen,' Kokum, Goa Butter tree and Kokum Butter tree (Kakade *et al*. 2019) [3]. Maharashtra has 1200 hectares of kokum cultivation and produces 10, 200 MT With an average yield of 8.5 t/ha (Karnik *et al*. 2001) [2].

The kokum butter obtained from the seed kernel is used in the manufacture of soaps, candles, ointments, and other pharmaceutical preparations especially in skin care products due to its ability to soften the skin and heal ulcers and fissures on lips, hand, and feet. It reduces the degradation of skin cells and restores elasticity (Kumar *et al*. 2001) [10]. Additionally, it is used as a ghee and confectionary butter alternative. In Ratnagiri, it is being employed to create excellent cocoa chocolates that are far less expensive than those made using cocoa butter (Subramanian 2016) [9].

India produces a variety of vegetable fats rich in stearic acid, including sal (Shorea robusta), dhupa (*Vateria indica*), mango (Mangifera indica) and kokum (*Garcinia indica*). Kokum is a small, slender, evergreen tree found in several parts of India. Tha fruit have three to eight large, black ovoid seeds and the kidney shaped kernels contain about 40% hard and brittle fat (melting point 39-43 ℃) with stearic acid being the major fatty acid. (Reddy and Maheshwari 2005) [5]. The major fatty acids present are stearic (50-60%) and oleic (36-40%) and the major triacylglycerols are 2-oleodistearin (SOS), present to the extent of about 70%. Because of this composition, the fat is hard and solidifies with a rough surface; hence it is used in chocolate and confectionery (Yella and Prabhakar). The present paper, shown that the kokum butter is used in chocolate making.

Material and Methods

The Kokum butter was procured from Sindhudurg, and Dapoli (Dist. Ratnagiri) Maharashtra. The Cocoa butter and Cocoa Powder were procured from online. The milk powder and Icing Sugar were procured from local market Dapoli (Dist. Ratnagiri). The experiment was conducted at the Department of Agricultural Process Engineering, College of Agricultural Engineering and Technology, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (M.S.). The experiment and chemical analysis were carried out in National Agricultural Innovation Project (NAIP) laboratory, Department of Agricultural Process Engineering, CAET, and the Department of Agricultural Chemistry and Soil Science, College of Agriculture, Dapoli.

The preparation of chocolate from kokum butter and the methods adopted for determination of physiochemical properties are given below.

Sample preparation

Receiving of ingredients (SMP, Sugar, Cocoa powder, kokum butter and cocoa butter)
↓
Weighing of ingredients
↓
Mixing of SMP, sugar and cocoa powder
↓
Addition of Kokum butter and Cocoa butter
↓
Place the mixed ingredients in an oven (110 °C for 30 mins)
↓
Moulding
↓
Refrigeration (25-30 mins)
↓
Packaging in Aluminum foil
↓
Storage

Fig 1: Process flow chart for preparation of kokum butter chocolate

Plate 1: Developed Kokum Butter Chocolate

Table 1: Composition of ingredients for chocolate making

Sr. No.	Ingredients (%)	C1	C2	C3	C4	C5	C6
1.	Kokum Butter	25	5	10	15	20	50
2.	Cocoa Butter	25	45	40	35	30	0
3.	Cocoa powder	10	10	10	10	10	10
4.	Icing Sugar	5	5	5	5	5	5
5.	Milk Powder	35	35	35	35	35	35
Total	100%						

Physiochemical Properties of kokum butter chocolate

Moisture Content

The moisture content of chocolate was determined by using the standard method of analysis (AOAC, 2000) [1]. The 5 g of chocolate sample was weighed in an empty petri dish and allowed to dry in a hot air oven maintained at 105 °C for 3 hours until a constant weight was achieved. After drying, it was cooled in a desiccator to room temperature with a partially covered lid. The difference in percentage weight was reported as moisture content. The moisture content on a wet basis was calculated by using the following formula:

$$MC\ (\%\ wb) = \frac{W_1 - W_3}{W_2 - W_3} \quad \text{.... (1)}$$

Where,
W1 = Initial mass of the test sample (g)
W2 = Final mass of the test sample (g)
W3 = Mass of empty sample box (g)

Protein content

It was determined by the Kjeldahl method (AOAC, 2000) [1]. The 0.5-1 g of sample was transferred to a digestion flask to which 5 g of catalyst mixture [9 parts of potassium sulphate (K_2SO_4) and one part of copper sulphate ($CuSO_4$)] and 20 ml of concentrated sulphuric acid was added. The content was digested till transparent liquid was obtained. The digested liquid was allowed to cool and 100 ml of distilled water was added. Then it was distilled with an excess of 40% NaOH solution and the liberated ammonia was collected in 50 ml of 4% boric acid solution containing 5-7 drops of mixed indicator [100 ml of 0.1% methyl red indicator (in 95% ethanol) + 200 ml of 0.2% bromocresol green (in 95% ethanol)]. The entrapped ammonia was then titrated against 0.1 N hydrochloric acid. A reagent blank was similarly digested and distilled. Nitrogen content in the sample was calculated as follows and a factor of 6.25 was used to convert nitrogen content to protein content.

The percent protein content was calculated by using the following formula:

$$Protein\ (\%) = \frac{(S-B) \times N \times 14.01 \times 100 \times 6.25}{W \times 1000} \quad \text{... (2)}$$

Where,
S = Volume of standard acid (0.1 N HCl) used for titration, ml
B = Volume of 0.1 N HCl used for blank, ml
W = Weight of the sample, g
N = Normality of acid used for titration (0.1 N HCl)

Crude fat content

Crude fat was estimated by the standard method (AOAC, 2000) [1] using Soxhlet extraction apparatus. A weighed sample of 2 g was kept in filter paper and wrapped. Then transferred it to an extraction thimble and dried overnight at 60 °C temperature. The thimble was placed in a Soxhlet extractor fitted with a condenser and flask containing sufficient petroleum ether (BP 60-80 °C). After 6h extraction, the thimble was removed from the extraction apparatus and dried in the hot air oven to a constant weight. It was then cooled in a desiccator to room temperature and weighed. The loss of weight of the sample in the thimble indicated the amount of fat in the sample.

$$\text{Fat (\%)} = \frac{\text{Loss of weight in the sample}}{\text{Weight of the sample}} \times 100 \qquad \ldots (3)$$

Ash content

Ash content was estimated by the standard method of analysis (AOAC, 2000) using a muffle furnace. The 5 g of dried sample was taken in weighed silica crucible without a lid and placed in a muffle furnace at 550 °C until ashing. Thereafter, the crucible was cooled in a desiccator and reweighed. The percent ash content was calculated based on the initial sample. Ash content was calculated by using the following formula:

$$\text{Ash Content (\%)} = \frac{(W_1 - W_2)}{W} \times 100 \qquad \ldots (4)$$

Where,
W1 = Weight of crucible + Weight of sample before heating, g
W2 = Weight of crucible + Weight of sample after heating, g
W = Weight of the sample, g

Crude fibre

The crude fibre was calculated by the standard method of analysis (AOAC, 2000) [1]. The 2 g of fat-free dried turmeric sample was weighed into a 500 ml beaker and 200 ml of 1.25% H2SO4 was added. The mixture was boiled for 30 minutes under bulb condensers and the beaker was rotated occasionally to mix the content and removed the particles from the sides. At the end of this period, the mixture was filtered through a muslin cloth, and the residue was washed with hot water till free from acid. The material was then transferred to the same beaker and add 200 ml of 1.25% sodium hydroxide (NaOH), which was brought to boiling point and boiled exactly for 30 minutes. All insoluble matter was transferred to the crucible using boiling water until it become acid-free, washed twice with alcohol (95% ethanol), dried at 100 °C to constant weight, reweighed, and ashed in a muffle furnace at 550 °C for 1 hour. Crucible was cooled in a desiccator, reweighed and the percentage of crude fiber in the sample was calculated using the formula:

$$\text{Crude fibre (\%)} = \frac{W_2 - W_3}{W_1} \times 100 \qquad \ldots (5)$$

Where,
W1 = Weight of the sample, g
W2 = Weight of insoluble matter, g
W3 = weight of ash, g

Carbohydrate

The carbohydrate content was calculated by using a standard method of analysis (AOAC, 2000) [1]. It was determined as per dry weight basis by subtracting the sum of percent moisture, protein, crude fat, crude fiber, and total ash from hundred and this will be reported as a carbohydrate by difference.

% Carbohydrates = 100 - (% Moisture + % Protein + % Fat + % Fiber + % Ash) (6)

Energy

The energy was calculated using the value of protein, fat, and carbohydrate. The percentage value of crude protein and carbohydrate by difference was multiplied by 4 and the percentage of crude fat by 9 and three values were added. (Sally *et al.*, 1996) [11]

Energy = (% crude protein × 4) + (% crude fat × 9) + (% carbohydrates × 4) (7)

Total Sugar

The total sugar was determined using the method given by Ranganna. From the clarified solution used for the estimation of reducing sugar, 50 ml was taken and boiled gently after adding citric acid and water. It was then neutralized with sodium hydroxide and the volume was made up to 250 ml. An aliquot of this solution was titrated against Fehling's solution A and B.

Reducing Sugar

Twenty-five gram of chocolates was ground with 100 ml of distilled water and transferred to a conical flask. It was neutralized with 1 N sodium hydroxide in the presence of phenolphthalein. For the clarification of the neutralized mixture, 2 ml of lead acetate was added followed by addition of 2 ml of potassium oxalate to neutralize the excess amount of lead acetate. It was then allowed to stand for 10 minutes for the settlement of the precipitate. Filtered the solution through Whatman's No.1 filter paper which was made up to 250 ml. Aliquot of the solution was titrated against a boiling mixture of Fehling's solution A and B using methylene blue as an indicator until the appearance of brick red colour indicator.

Sensory Evaluation of Kokum Butter Chocolate

Sensory Evaluation of the Kokum Butter Chocolate samples was carried out by 25 panelists on a 9-point hedonic scale. All the chocolates including control were judged by 25 semi-trained panelists of age group 20-25 years consisted of students, staff, and faculty members from the CAET, Dr. BSKKV, Dapoli (MS) using standard method. The panelists were trained about the concepts and scoring systems about the following attributes: Colour, Flavour, Taste, Appearance and Overall acceptability. Samples of all the treatments were served to each panelist to taste each sample one after another with due interval in between. Panelists were provided with a glass of water and instructed to rinse and swallow water between samples and were served potato chips to break the monotony in taste of the chocolates. To analyse results numerical values were assigned to each point on the scale, 9 points for like extremely and I point for dislike extremely. Mean sensory scores for quality attributes (Colour, flavour, taste, texture, appearance, and overall acceptability) were recorded on the given score sheet. Hence samples of chocolate made with kokum butter, cocoa butter, cocoa powder, skimmed milk powder and icing sugar baked at 110 °C were presented to the panelists.

Results and Discussion
Physiochemical properties of Developed Kokum Butter Chocolate
The physiochemical properties of developed kokum butter chocolate are listed below for different treatments.

Table 2: Physiochemical Properties of Developed Kokum Butter Chocolate

Sr. No.	Physiochemical Properties	C1	C2	C3	C4	C5	C6	Control
1	Moisture content, (%)	3.34	3.9	3.8	3.52	3.35	3.48	4.5
2	Crude Protein, (%)	18.33	15.83	12.30	14.53	13.83	16.78	7.3
3	Crude Fat, (%)	7.8	8	7.6	7.23	7.92	8.22	1.15
4	Crude Fibre, (%)	1.24	1.02	1.5	1.32	1.26	1.31	0.45
5	Ash content, (%)	2.23	2.5	2.24	2.32	2.46	2.28	2.5
6	Total sugar	119.5	119.20	119	118.93	119.06	119.58	37
7	Reducing sugar	78.5	78.65	78	78.62	79.02	78.82	27
8	Energy, kcal/100 gms	410.04	412.32	407.68	407.51	411.16	412.82	408.86
9	Carbohydrates, (%)	66.63	69.25	72.52	71.08	71.14	67.93	63

From the observation, the highest moisture content was 3.52 for the C4 developed chocolate and lowest for the C1 developed chocolate was 3.34. From the data, the highest value of protein was for the C1 developed chocolate was 18.33 and lowest for the 12.30 was for the C3 developed chocolate. From the data, the highest value of the fat was 8.22 for the C6 developed chocolate and the lowest was for the C3 developed chocolate was 7.6. From the data, the highest value of the fibre was 1.5 for the C3 developed chocolate and the lowest was for the 1.02 was for the C2 developed chocolate.

From the data, the highest value of the ash content was 2.5 for the C2 developed chocolate and the lowest was for the developed chocolate was 2.2. From the data, the highest value for the total sugar was 119.58 of the C5 developed chocolate and the lowest was for the C3 developed chocolate was 119. From the data, the highest value of reducing sugar was 79.02 of the C5 developed chocolate and the lowest was for the C3 developed chocolate was 78. From the data, the highest value of energy was 412.82 of the C6 developed chocolate and the lowest was for the C4 developed chocolate was 407.51. From the data, the highest value of carbohydrates was 72.52 for the C3 developed chocolate and the lowest was for the C1 developed chocolate was 66.63.

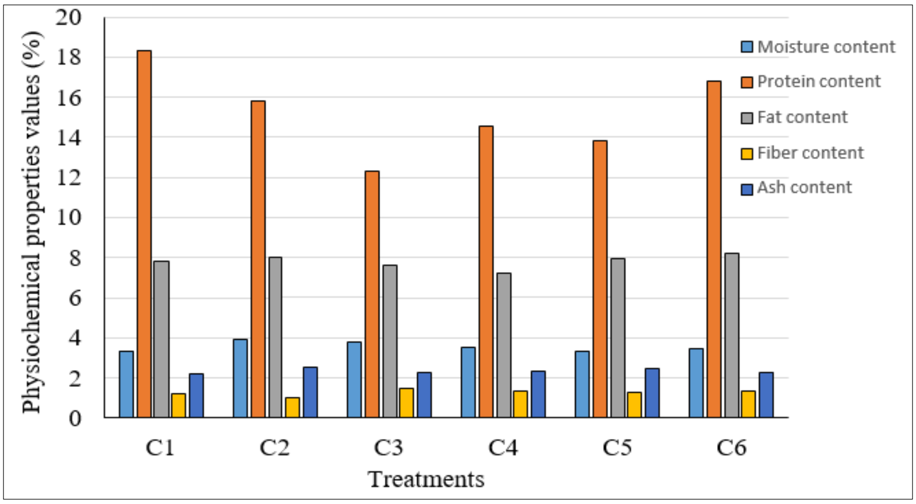

Fig 2: Physiochemical properties of developed kokum butter chocolate

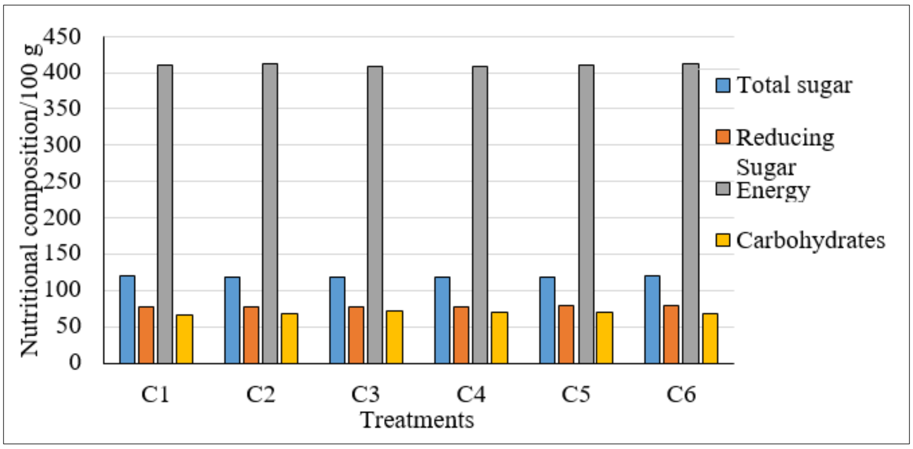

Fig 3: Physiochemical properties of developed kokum butter chocolate

Sensory Evaluation of Developed Kokum Butter Chocolate

The organoleptic evaluation of developed kokum butter chocolate samples was carried out using the sensory panels of 25 different age group people following standard procedure of 9-point hedonic scale. All the kokum butter chocolate samples were made and presented to semi-trained panelists which then evaluated organoleptically for different quality attributes such as colour, flavour, taste, texture, appearance, overall acceptability. Chocolate from the local market C7 was acted as a control sample and the rest were made by kokum butter.

Table 3: Sensory evaluation of kokum butter chocolate

Treatments	Colour and Appearance	Flour	Texture	Taste	Overall Acceptability
C1	8.68	8.36	8.52	8.76	8.68
C2	8.48	7.84	7.72	7.12	7.48
C3	8.52	7.68	8.12	7.92	7.84
C4	8.64	8.44	8.2	8.68	8.48
C5	7.44	6.64	8	6.64	6.8
C6	7.72	6.52	8.56	5.72	6.28
Control	9	9	9	9	9

The data for sensory evaluation was given in the Table 2 and the variation in the sensory attributes with the addition of kokum butter along with the cocoa butter and cocoa powder at 110℃ baking temperature was shown in the Table 2. From the data it was revealed that the panelists could significantly differentiate the chocolates incorporated with blends of kokum butter and cocoa butter. The maximum score (8.68) for colour was obtained by chocolate C1 (75:75) followed by the chocolate incorporated with 15% kokum butter (8.64) and the minimum (7.44) was obtained by chocolate C5 (60:90) incorporated with 20% kokum butter baked at 110 ℃.

From the data for texture, the maximum score was found for C6 samples (8.56) followed by the chocolate incorporated with the 25% kokum butter (8.52) and the minimum (7.72) was obtained by chocolate C2 (15:135) incorporated with 5% kokum butter baked at 110 ℃. It was showed that with increase in kokum butter percentage texture of chocolate became harder. This may be because with the addition of kokum butter chocolate hardness increases which ultimately affects its texture.

The score obtained for sensory evaluation of chocolate showed that the maximum score for taste was found for chocolate C1 prepared with 25% kokum butter followed by C4. It was showed that the equal percentage of kokum butter and cocoa butter chocolate sample was preferred by the panelists instead of C6 sample with 50% kokum butter.

The data of flavour revealed that maximum score (8.44) was obtained for C4 (45:105) sample followed by C1 with 25% kokum butter, whereas chocolate with 50% of kokum butter were least preferred. The overall acceptability data showed that maximum score (8.68) was found for chocolate formulated with the 25% kokum butter baked at 110℃ and minimum (6.28) score was obtained by chocolate with 50% kokum butter.

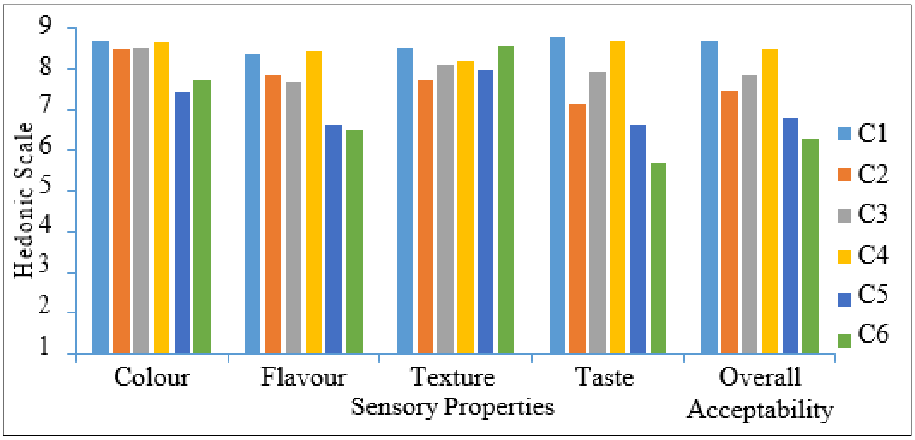

Fig 4: Effect of different proportions on the sensory properties of developed kokum butter chocolate

The cost of production for the developed kokum butter chocolate was found to be Rs. 831.93/kg. The cost of production for the control sample was found to be Rs. 999.78/kg. Compared to the control sample the developed kokum butter chocolate sample was less expensive.

Conclusion

In this experiment chocolates have been prepared using kokum butter by mixing with it cocoa butter in different proportion percentage *viz* 5%, 10%, 15%, 25% and 50%. Following conclusions were drawn the present experiment:

1. The chocolate made with kokum butter mixed with cocoa butter gave the best result 25 percentage by volume of kokum butter.
2. The physiochemical properties of 25% by volume of kokum butter chocolate are better in comparison with rest of the kokum butter proportions used in the experiment. The protein was 15.58%, the carbohydrate was 69.16%, the energy was 409.16 kcal/100 gm, the fibre was 7.8% and ash content was 2.2%.
3. The cost estimation of the kokum butter chocolate has been done that was rupees 831.93/kg which was lesser than the locally available chocolates.

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