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Mineral Composition of Coconut Candy Made from Chocolate, Sugar, Honey and Coconut

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Abstract
Value addition of coconut has a vital role to develop new products for increasing the income of the people. Coconut products and by-products can be commercially exploited for multiple purposes. The making of candy allows the researcher to learn and take into account many scientific aspects of food production. The study assessed the mineral composition of coconut candy produced. Coconut and original honey used in this study was procured at Sayedero market in Ilaro, it was packed in a sterile polythene bag which was later transported to the Federal Polytechnic, Ilaro Food Processing Laboratory prior to further processing. Other materials such as;honey, sugar, chocolate were also used in this study. Mineral analysis of this study revealed that coconut candy made from coconut, sugar, honey and chocolate contained traces of essential minerals which include; magnesium, calcium, potassium and no traces of manganese. Analysis of this study revealed that magnesium content ranged from 85.18±0.00 to 97.54±0.00%, calcium composition ranged from 12.53±0.04% to 23.81±0.01 while the potassium composition of the coconut candyranged from 499.35±0.07 to 666.30±0.00%. and no traces of manganese was observed in the samples. This study has clearly shown possibility of utilization of coconut, sugar, honey and chocolate for production of candy. This would support industrial utilization and the consumption of under-utilized crops such as coconut.

Keywords: Coconut, sugar, honey, chocolate and magnesium.

1. Introduction

Coconut (*Cocosnucifera*) is the most important versatile crop, which provides all required amenities for human life *(Chambers et al., 2015).* Value addition of coconut has a vital role to develop new products for increasing the income of the people. Coconut provides a nutritious source of meat, juice, milk, and oil that has fed and nourished populations around the world for generations. On many islands coconut is a staple ingredient in the diet. Nearly one third of the world's population depends on coconut to some degree for their food and their economy. Coconut is rich in fiber, vitamins, and minerals. It is believe as a "functional food" because it provides many health benefits beyond its nutritional content. Coconut is naturally low in digestible carbohydrate, contains no gluten, is cheaper than most other nut flours, is loaded with health promoting fiber and important nutrients, and tastes terrific. Coconut products and by-products can be commercially exploited for multiple purposes. Features (Ekeanyanwu *et. al*., 2010). Candy, also called sweet and lollies in some parts of the world (Chandrasekaran, 2015) is a confection, a sweet kind of food made usually from sugar and water, with flavours and some other ingredients like nuts, milk or butter added (Edwards, 2018). Its principal ingredient is sugar from sugar beet or sugarcane (Eaggleston *et al.,* 2017; Edwards, 2018). It can be found in almost any store and is consumed by many people despite its low nutritional benefits (Edwards, 2018). It comes in different flavours, sizes and shapes and apart from having a sweet taste, it can be spicy too. Candy also encompasses sweet confections like chocolate, caramel, chewing gum and sugar candy as well as vegetables, fruits or nuts which have been glazed and coated with sugar. Generally, candies are rich in artificial sweeteners which are low in nutrients but rich in calories. They are mostly consumed by children (Bailey *et. al.,* 2018). Coconut candy refer to various candies made with coconut or coconut flavorings. Coconut candy is most commonly produced with coconut milk and coconut cream. In the United States, coconut candy was sometimes spelled as cocoanut candy (Ekeanyanwu *et. al*., 2010). It is often flavoured and sometimes contains fruit, nuts, etc. Technically, milk or chocolate can be added to sugars mixtures in candy processing depending on the variety. The utilization of animal milk in candy production results in their unavailability in most African markets

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Samples	Coconut (g)	Sugar (g)	Honey (g)	Chocolate
A	80	10	10	+
B	80	20	-	+
C	80	20	-	-
D	80	-	20	+
E	80	-	20	-
F	80	10	10	-

Table 1: Coconut candy was produced using coconut water, chocolate, honey and sugar at different proportions.

and to their high price of purchase. Other milks from plants can be investigated in the production of confectionaries especially candy (Sunny-Roberts, 2007). Nutritional deficiency disease due to intake of local candies with high protein, fibre, mineral and vitamin is common (WHO, 2000). Under-nutrition in Nigeria is mainly due to poverty, inadequate energy intake as well as protein and micronutrients owing to poor nutrition education. However, effort geared towards addressing deficiency of trace minerals and food contamination through intake of local candies necessitates this study.

2. Materials And Methods

2.1 Materials

Coconut and original honey used in this study was procured at Sayedero market in Ilaro, it was packed in a sterile polythene bag which was later transported to the Federal Polytechnic, Ilaro Food Processing Laboratory prior to further processing. Coconut candy was produced and slightly modified using method described by Sunny-Roberts (2007). About 20ml of coconut water was poured in a clean, sterile iron pot then, sugar, honey was added and heated under heat source for 2minute. Then, grated coconut was added and stirred continuously for about 5minutes until it turned brown. It was then poured on a sterile tray and mold into a suitable molds to form candy. Molded candy was then dipped into chocolate for 20 minutes. The candy were wrapped in an aluminum foil and stored in an airtight container and kept under refrigerated condition for it to solidify prior to analysis. Atomic absorption spectroscopy (AAS) was used for the mineral determination. Atomic absorption spectrophotometric (Perkin-elmal model 403, Norwark, CT, USA) was used to determine the levels of calcium, manganese and magnesium in the samples after digestion with concentrated nitric acid as described by Association of Official Analytical Chemists (AOAC, 2010). Potassium was determined colorimetrically using spectronic 20 (Gallenkap, UK) with KH_2PO_4 as standard.

Samples Preparation

Production of Chocolate

Chocolate was produced as described by Onyekwelu (2018). Coco powder of 50g was poured in a clean bowl. 75g of butter was added and stirred to remove lumps. Then, 120g of water was poured in a sterile pot under heat source and mixed with coco powder. 65g sugar and120g of milk was added and it was stirred continuously.

Materials Formulation

Production of Coconut Candy

Coconut candy was produced and slightly modified using method described by Sunny-Roberts (2007). About 20ml of coconut water was poured in a clean, sterile iron pot then, sugar, honey was added and heated under heat source for 2 minute. Then, grated coconut was added and stirred continuously for about 5minutes until it turned brown. It was then poured on a sterile tray and mold into a suitable molds to form candy. Molded candy was then dipped into chocolate for 20 minutes. The candy were wrapped in an aluminum foil and stored in an airtight container and kept under refrigerated condition for it to solidify prior to analysis.

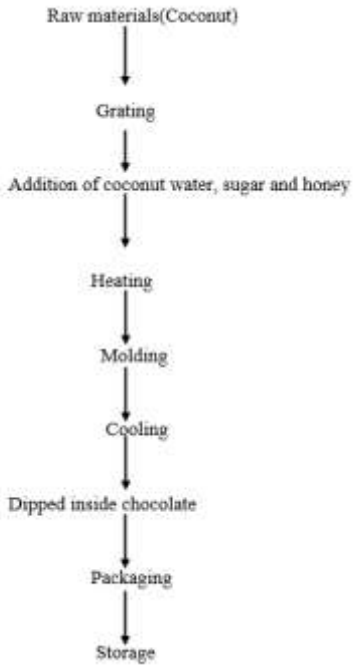


Figure 1: Flow Chart for Production of Coconut Candy

Mineral Determination

Atomic absorption spectroscopy (AAS) was used for the mineral determination. Atomic absorption spectrophotometric (Perkin-elmal model 403, Norwark, CT, USA) was used to determine the levels of calcium, manganese and magnesium in the samples after digestion with concentrated nitric acid as described by Association of Official Analytical Chemists (AOAC, 2010). Potassium was determined calorimetrically using spectronic 20 (Gallenkap, UK) with KH2PO4 as standard.

Table 2: Mineral Composition of coconut candy

Sample code	Potassium Mg/100g	Calcium Mg/100g	Magnesium Mg/100g	Manganese Mg/100g
A A	666.30±0.00	18.27±0.00	94.53±0.00	ND
B B	572.60±0.14	19.03±0.00	87.69±0.00	ND
C C	662.20±0.00	23.81±0.01	97.54±0.00	ND
D D	623.10±0.00	22.79±0.00	89.30±0.00	ND
E E	586.40±0.00	18.76±0.00	85.18±0.00	ND
F	499.35±0.07	12.53±0.04	72.29±0.00	ND

Value of triplicate mean ± standard deviation determination with the significant different in ($p<0.05$).

KEY:

Sample A Coconut: sugar: honey with chocolate (80:10:10)
Sample B Coconut: sugar: with chocolate (80:20)
Sample C Coconut: sugar: without chocolate (80:20)
Sample D Coconut: honey with chocolate (80:20)
Sample E Coconut: honey without chocolate (80:20)
Sample F Coconut: sugar: honey without chocolate (80:10:10)

Mineral Analysis

Procedure for digestion

About 0.5 to 1.0g of ground materials was weighed (oven dry at 60^0C) into a 125ml Erlenmeyer flask which have been previously washed with acid and distilled water. 4ml of perchloric acid was added, 25ml conc. HNO_3 and 2ml conc. H_2SO_4 under a fume hood. Mix the contents and heat gently at low to medium heat on a hot plate under Perchloric acid fume hood.It was continued heating until dense white fumes appear. If any traces of carbon remain, allow the flask to cool and add 1-2ml conc. HNO_3 and digest again to the fuming stage. Finally, heat strongly (medium to high heat) for half a minute. It was Allowed to cooled, then 40-50ml distilled water was added. It was then boiled for half a minute on the same plate at medium heat.Cool and filter the solution completely with a was bottle into a 100ml pyrex volumetric flask. Make up to mark with distilled water (Whatman no.42 filter paper 9cm). Store the solution for P and Fe determinations (colorimetry), Zn, Ca, and Mg determinations (atomic absorption spectrometry), Na, K, determination (flame photometry).

2.2 Method of Data Analysis

Data obtained were subjected to Analysis of Variance (ANOVA). Difference between means were evaluated using Tukey's multiple comparison tests with 95% confidence level. The statistical package SPSS software version 26 was used.

3. Results and Discussion

Table 2 indicate the mineral composition of coconut candy. Magnesium content ranged from 85.18±0.00 to 97.54±0.00%. Sample C coconut: sugar:without chocolate (80:20) has the highest magnesium composition followed by sample A coconut: sugar: honey with chocolate (80:10:10) and Sample B with coconut: sugar: with chocolate (80:20) with the value of 97.54±0.00%, 94.53±0.00% and 87.69±0.00%. The values in this study agrees with the values reported by Kaur*et. al.* (2023).Sample F coconut: sugar: honey without chocolate (80:10:10) has the least magnesium composition of 72.29±0.00%. Magnesium is involved in making protein and in releasing energy (Nikooei*et.al*.,2021). Magnesium helps hold calcium in the enamel of the teeth (Arshad*et.al*., 2022). Magnesium has been reported to be involved in maintaining the electrical potential in nerves and activation of some enzyme systems. In addition, calcium composition ranged from 12.53±0.04% to 23.81±0.01%. Sample C coconut: sugar: without chocolate (80:20) has the highest calcium composition with 23.81±0.01% followed by sample D Coconut: honey with chocolate (80:20) with the value of 23.81±0.01 to 22.79±0.00%. However, Sample F coconut: sugar: honey without chocolate (80:10:10) has the least percentage of calcium with the value of 12.53±0.04%. This values obtained from this study are higher than the values of 8.22± 0.01 obtained by Amadi*et. al.,* (2025) who worked on coconut candy with refined sugar and coconut.Calcium is one of the main components of teeth and bones.The consumption of this candy can reduce dental caries which is a major health challenge associated with the consumption of candy made with refined sugar (Amadi*et. al.,* 2025). Calcium ensures proper muscle action, a regular heartbeat and steady concentration of ions both inside and outside body cells. It also plays a role in blood clotting (Mehas and Rodgers, 2015). Phosphorus is closely linked with calcium. These two minerals combine to form calcium phosphate, which give bones their strength and rigid structure. The potassium composition of the coconut candy ranged from 499.35±0.07 to 666.30±0.00%. Sample A coconut: sugar: honey with chocolate (80:10:10) has the highest

potassium composition followed by sample E Coconut: honey without chocolate 80:20). This might be as a result of chocolate being rich in potassium (Siddeeg, 2019). Potassium helps to regulate blood pressure, nerve function, and muscle contraction (Castro-Munoz *et. al.,* 2021). Sample B coconut: sugar: with chocolate (80:20) with the value of 666.30±0.00, 586.40±0.00 and 572.60±0.14 respectively. Sample F coconut: sugar: honey without chocolate (80:10:10) has the least potassium composition with the value of 499.35±0.07%. Potassium was the most abundant mineral element in the seed flours and these results are in agreement with the observation of Nikooei*et. al.,* (2021), that potassium is the most predominant element in Nigerian agricultural products. The high concentration of potassium will help to regulate acid-base balance and normal metabolism (Foale*et. al.*, 2020). Furthermore, across the table, no traces of manganese were observed in the samples.

4. Conclusion And Recommendation

Mineral analysis of this study revealed that coconut candy made from coconut, sugar, honey and chocolate contained traces of essential minerals which include; magnesium, calcium, potassium and no traces of manganese. Thus, this study has clearly shown possibility of utilization of coconut, sugar, honey and chocolate for production of candy. This would support industrial utilization and the consumption of under-utilized crops such as coconut. Coconut candy supplemented with honey should be recommended for children and adults in order to reduce the health challenges associated with excess consumption of sugar in candies.

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Contribution of the Authors

This work was carried out in collaboration with all authors. Authors Ajao, Noah, lmade and Anuoluwatelemi, designed and wrote the study protocol. Authors Kusamotu, Adeyilola, Osokolo, Oladunmoye, Adetoboye, and Abel conducted the documentary research, conducted the laboratory analyses, the statistical analysis and the first draft and revised the manuscript. Authors Sarumi and Familola took part in the interpretation of the results and provided a major contribution in the elaboration of the final document.

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