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FOREWORD

It is with great delight I welcome you to volume 4 issue 2 of Federal Polytechnic – Journal of Pure and Applied Sciences (FEPI-JOPAS). It is a peer-reviewed open-access multi-disciplinary Journal of global recognition which is referenced and indexed in African Journal Online (AJOL). It is a highly commendable Journal that publishes excellent research contributions and exhibiting also special attention to experience papers coming from the many application areas of pure and applied Sciences. FEPI-JOPAS publishes full-length research work, short communications, critical reviews and other review articles.

The aim of FEPI-JOPAS is to provide intellectual bedrock for both indigenous and international scholars with quality research outputs to express and communicate their research findings to a broader populace. It serves as a valuable platform for the dissemination of information to 21st Century researchers, professionals, policymakers, manufacturers, production staff, R & D personnel as well as governmental and non-governmental agencies. It also aimed to provide a platform for academics and industry practitioners to share cases on the application of management concepts to complex real-world situations in pure and applied sciences and related fields.

This volume 4 issue 2 of FEPI-JOPAS is loaded with quantum and well-featured diversity of trending topics in applied and basic research. These hot and trending topics are: Sustainable Art and Design: Activating Sighting as the Phenomenon of Representational Drawing; Assessment of Heavy Metals in Processed Meat (Tinko) Sold within Igbesa Community; The Hypoglycemic Effect of Musa Sapientum in Alloxan Induced Diabetic Albino Wistar Rat; Rainwater Quality Evaluation for Agricultural Use: Case Study of a Portland cement Producing Area; Analytical Approach to Investigating the Influence of Blood Group and Blood Genotype on the Performance of Students of Federal Polytechnic, Ilaro; Dough Mixing Time: Impact on Dough Properties, Bread-Baking Quality and Consumer Acceptability; Chemical Composition of Harvested Rainwater Around a Cement Factory in Ibeshe, Yewa North, Ogun State.

Furthermore, other topics to be encountered in this issue that have added colour and beauty to this edition are: Physicochemical properties and sensory evaluation of milk candy ‘toffee’ (a

NIGERIA candy) enrich with coconut, tigernut and groundnut; Informal Settlements in Developing Countries: Issues, Challenges and Prospects; Comparison of Sensory Properties of Meals Produced from Cowpea and Pigeon Pea; Automated Lecture Timetable Generation Using Genetic Algorithm; Septic Tanks Contamination in Groundwater Quality around Elementary Schools in Ibadan, Oyo State Nigeria; and Waste Disposal Systems in Some Selected Abattoirs Located in Ilaro Metropolis. FEPI-JOPAS has been centered on discerning the changing needs of the academic world and is committed to advancing research around the world by publishing the latest research in various academic fields and ensuring that the resources are accessible in print, digital, and online formats.

In addition, I would like to thank many people who worked so hard to ensure that publishing this issue 2 of volume 4 is a reality. I would like to thank the Editorial Board for their guidance and the publishing team for the continued support and effort in streamlining the publication process. I am grateful to the reviewers who provided timely and constructive reviews for the papers assigned to them. The authors are solely responsible for the information, date and authenticity of data provided in their articles submitted for publication in the Federal Polytechnic Ilaro – Journal of Pure and Applied Sciences (FEPI-JOPAS).

I am looking forward to receiving your manuscripts for the subsequent publications. You can visit our website (https://fepi-jopas.federalpolyilaro.edu.ng) for more information, or contact us via e-mail us at fepi.jopas@federalpolyilaro.edu.ng

Thank you and best regards.

Prof. Olayinka Oyewale AJANI

(Editor-in-Chief)

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Physicochemical properties and sensory evaluation of milk candy 'toffee' (a NIGERIA candy) enrich with coconut, tigernut and groundnut

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Abstract

The proximate composition and sensory properties of candies produced with different blends of coconut, tiger nut and groundnut were investigated. Eight (8) samples and a control (100% condensed milk) were developed in ratios as: AC (90:10 condensed milk and coconut), BC (90:10 condensed milk and tiger nut), CC (90:10 condensed milk and groundnut), DC (80:10:10 condensed milk, coconut, and groundnut), EC (80:10:10 condensed milk, tiger nut, and groundnut), FC (80:10:10 condensed milk, coconut, and groundnut) and GC (70:10:10:10 condensed milk, coconut, groundnut and tiger nut). Moisture, ash, fat, protein, crude fibre, and carbohydrate contents of the candy samples showed significant differences and were recorded as 2.03-4.24%, 3.86-6.84%, 6.43-18.22%, 1.13-1.84%, 0.64-1.11 and 68.48-82.98% respectively. The pH for all the candy samples ranged from 6.02 to 6.10. Sensory analysis revealed significant difference in colour, aroma, texture, taste, mouthfeel, and overall acceptability. An acceptable candy can be developed from condensed milk fortified with coconut, tiger nut and groundnut milk. Sample AC and DC were with the highest scores were mostly preferred by the panelist. Hence, value-added products (candy) could be developed using coconut, groundnut and under-utilized tiger nut reducing the burden of high cost of animal milk.

Keywords: Milk candy, physicochemical, sensory, temperature.

INTRODUCTION

High cost of animal milk in the recent time due to the post-COVID pandemic and farmers-herdsmen clash, have made consumers of milk to shift their interest towards plant-based milk or alternative milk. Plant-based milk contains no cholesterol and has the potential to promote human health (Aydar, *et al*, 2020). Milk is an important source of nutrients to humans and animals; about 87% of water is what is present in milk and the remaining part comprises total solids, i.e., carbohydrates, fat, proteins, and minerals contained in a balanced form and digestive elements for building and maintaining the human and animal body. Other milk ingredients include immune globulins which protect the newly born against a number of diseases (Randey & Voskiiil, 2011). Condensed milk is defined as cow's milk from which water has been removed. It is most often found in the form of sweetened condensed milk, with sugar added and the term condensed milk and sweetened condensed milk are often used interchangeably.

Tiger nut (*Cyperus esculentus*) the yellow nut sedge is a species of sedge (Adejuyitan, 2011). The main components of tiger nut are carbohydrates' energy value, starch content, dietary fiber content, protein, and sucrose content (USDA, 2018). Tiger nut milk refers to the milk extracted directly from tiger nuts. It is a nutritional and nourishing drink recommended to be taken any time of the day, or year, most especially during the drying season.

The coconut tree (*Coco nucifera*) is a member of the palm tree family *Arecaceae* (Patil, 2016). Raw

coconut supplies a high amount of total fat especially saturated fat, moderate content of carbohydrates and protein. Coconut milk plays an important part in the diet. It is valued mainly for its characteristic nutty flavour as well as its nutritional content. Coconut milk contains water, total fat, carbohydrate, and protein. Coconut milk is a good source of manganese and an adequate source of phosphorus, iron, and magnesium with no other nutrients in significant content (Henni, 2010). Groundnut is grown for its oil and edible nuts. Groundnut seed contains 44-56% oil and 20-30% protein on a dry seed basis and is a rich source of minerals and vitamins (Savage and Keena, 1994).

Candy is a type of confectionery that describes a spectrum of sweet goods and takes on different meanings from one country to the other. Candy is defined as a highly cooked coloured and flavoured sugar mass formed into desired shapes. It is a more or less solid article of confectionary made by boiling sugar to the desired consistency, and then crystallizing moulding or working in the required shape (Sunny-Roberts, 2007). Candy also called sweets, is a confectionary that features sugar as a principal ingredient and encompasses any sweet confection, including chocolate, chewing gum, sugar candy, vegetable, fruits, or nuts which have been glazed and coated with sugar (Chambers *et al*, 2015). Is enjoyed by both children and adults and is high in carbohydrates.

With our literature search, there is insufficient studies on candy developed from plant-based milk majority are animal-based milk. Therefore, this study seeks to evaluate the physicochemical and sensory properties of milk candy ‘toffee’ (a Nigeria candy) enrich with plant-based milk (coconut, tiger nut, and groundnut), with aim of developing an acceptable and rich candy.

MATERIAL AND METHODS

Source of Materials

Coconut, groundnut, and tiger nut were all purchased from a retail market, “Sayedero” while granulated sugar, condensed milk, groundnut oil was bought from a reputable store all in Ilaro metropolis, Ogun State. All the ingredients were kept in at room temperature till needed for processing.

Formulation of the candies sample

Candy (toffee) was produced with condensed milk, groundnut, tiger nut, and coconut fruit using different formulations (Table 1).

Table 1: Materials Formulation for Candies Sample (%)

Samples code	Condensed Milk	Groundnut	Tiger nut	Coconut
Control	100	-	-	-
AC	90	-	-	10
BC	90	10	-	-
CC	90	-	10	-
DC	80	10	-	10
EC	80	10	10	-
FC	80	-	10	10
GC	70	10	10	10

KEY:
Control = 100% condensed milk
AC = Condensed milk: Coconut (90:10)
BC = Condensed milk: Groundnut (90:10)
CC = Condensed milk: Tiger nut (90:10)
DC = Condensed milk: Coconut: Groundnut (80:10:10)
EC = Condensed milk: Tiger nut: Groundnut (80:10:10)
FC = Condensed milk: Coconut: Tiger nut (80:10:10)
GC = Condensed milk: Coconut: Tiger nut: Groundnut (70:10:10:10%)

Production of Condensed Milk Candy (Toffee)

Condensed milk candies were produced using the method described by Sunny-Roberts (2007) with slight modifications. These were done by enriching with tiger nut, coconut, and groundnut at different levels. The tiger nut was picked, cleaned, and washed before blending, the coconut shell was removed, cleaned, and grated while the groundnut was picked, cleaned, and pounded using mortar and pestle which were set aside for further processing in order not to use water and to maintain the required size. A clean stainless pot was placed on a gas cylinder, for easy removal of the candy after production. About 680 g of condensed milk was placed inside an oily pot and heated for 10minutes, stirring simultaneously to ensure equal distribution, and avoiding lumps formulation until it turned brown. The browning colouration occurred around 95ºC after which it was poured into a sterile iron tray. Tiger nut, coconut and groundnut were incorporated into it at different levels according to the formulation and moulded into desired shapes. The condensed milk cadies were wrapped with aluminium foil stored in airtight container and under ambient temperature for solidification.

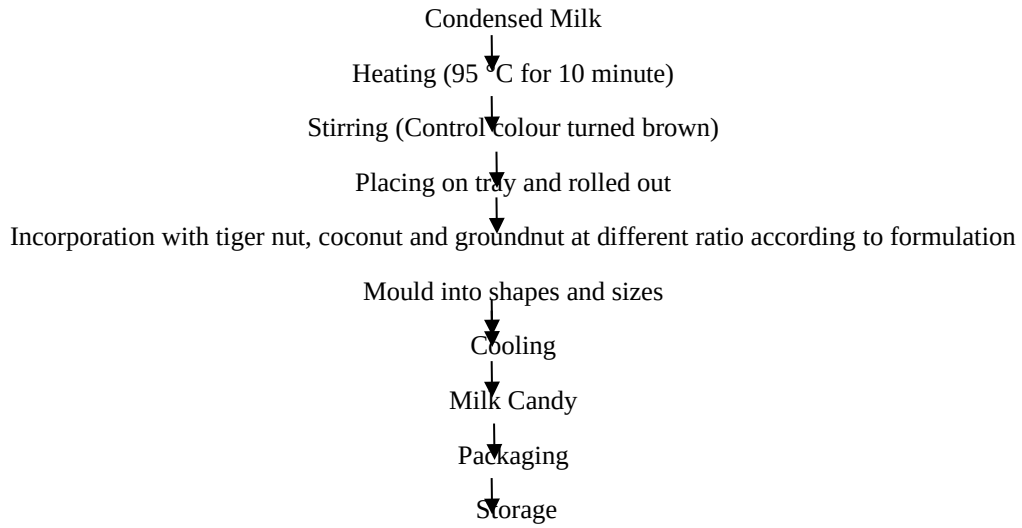

Fig 2: Flow Chart for the Production of Condensed Milk Candy (Toffee)

(Sunny-Roberts, 2007)

Fig 1: Processed Condense Milk Candy (Toffee)

Analyses

The proximate composition and pH of the milk candies produced was carried out using standard analytical of methods (AOAC, 2010).

Sensory evaluation

Sensory evaluation of the candy samples was carried out by using 27 semi-trained panellists (12 females and 15 males). Panellist were recruited amongst the staff and student within the polytechnic community (aged between 15 and 23 years) and volunteered to take part in the evaluation. Milk candies were presented in a cleaned glass plate, coded with 3-digit random number in a randomised design. Candies were evaluated for taste, colour, texture, appearance, and overall acceptability, using a 9-point hedonic scale (raging from minimum of 1 = dislike extremely to maximum of 9 = like extremely). Panellists were seated in separate evaluation booth in a standard sensory laboratory, Portable water was provided for the panellists to cleanse their palate in-between the evaluation.

Statistical analysis

Experimental data generated were subjected to one-way analysis of variance (ANOVA) and Duncan's multiple range test (DMRT) was used to separate means at $p<0.05$. Results were presented as mean ± standard deviation of replicate determinations. Statistical package for social sciences (SPSS version 23.0) for windows was used to analyse the data.

RESULT AND DISCUSSION

Result

Table 2 shows the proximate composition of condensed milk candy enrich with coconut, tiger, and groundnut. Moisture, protein, fat, ash, crude fibre, and carbohydrate were significantly different ($p<0.05$) among the candy samples. Moisture, protein, fat, ash, crude fibre, and carbohydrate contents varied as 2.03-4.24%, 3.86-6.84%, 6.43-18.22%, 1.13-1.84%, 0.64-1.41% and 6.8.48-82.98% respectively. Highest values for Moisture, protein, fat, ash, crude fibre, and carbohydrate were recorded in samples AC, GC, GC, EC, EC, and AC respectively while lowest values were in FC, AC, AC, BC, BC, and GC respectively for moisture, protein, fat, ash, crude fibre, and carbohydrate contents.

Table 2: Proximate composition of condensed milk candy enrich with coconut, tiger nut and groundnut

	Proximate composition (%)					
Sample	**Moisture**	**Protein**	**Fat**	**Ash**	**Crude Fibre**	**Carbohydrate**
Control	2.58±0.02^{b}	4.25±0.01^{b}	16.46±0.02^{b}	1.51±0.02^{b}	1.26±0.01^{b}	71.36±0.01^{a}
AC	4.24±0.02^{d}	3.86±0.02^{a}	6.43±0.03^{a}	1.24±0.03^{a}	0.87±0.02^{a}	82.98±0.03^{b}
BC	2.63±0.03^{c}	6.41±0.02^{c}	10.12±0.02^{ab}	1.13±0.03^{a}	0.64±0.02^{a}	81.23±0.03^{b}
CC	3.02±0.02^{ab}	4.26±0.02^{b}	11.18±0.02^{ab}	1.43±0.03^{ab}	1.04±0.01^{ab}	79.46±0.03^{ab}
DC	2.42±0.03^{ab}	6.32±0.02^{c}	16.13±0.03^{b}	1.71±0.02^{c}	1.22±0.02^{b}	72.20±0.01^{a}
EC	3.04±0.02^{c}	6.63±0.03^{c}	17.43±0.03^{c}	1.84±0.02^{c}	1.41±0.01^{c}	69.65±0.01^{a}
FC	2.03±0.02^{a}	6.62±0.02^{c}	16.23±0.03^{b}	1.73±0.03^{b}	1.24±0.03^{b}	72.15±0.01^{a}
GC	3.92±0.03^{c}	6.84±0.03^{c}	18.22±0.02^{c}	1.64±0.02^{b}	1.33±0.03^{c}	68.48±0.04^{a}

Values are presented as mean± standard deviation of replicate determination (n=3). Means with different superscripts within the same column were significantly ($p\leq0.05$) different.

KEY: Control = 100% condensed milk; AC = Condensed milk: Coconut (90:10); BC = Condensed milk: Groundnut (90:10); CC = Condensed milk: Tiger nut (90:10); DC =Condensed milk: Coconut: Groundnut (80:10:10); EC = Condensed milk: Tiger nut: Groundnut (80:10:10); FC = Condensed milk: Coconut: Tiger nut (80:10:10); GC = Condensed milk: Coconut: Tiger nut: Groundnut (70:10:10:10)

Table 3 shows the pH values of condensed milk candy enrich with coconut, tiger nut and groundnut. The pH values are significantly different ($p<0.05$) among the candy samples. However, the pH values of the candy samples ranged between 6.02 and 6.10.

Table 3: The pH of condensed milk candy enriches with coconut, tiger nut and groundnut

Sample	pH
Control	6.10±0.03 [a]
AC	6.02±0.03[b]
BC	6.06±0.03[b]
CC	6.05±0.03[b]
DC	6.05±0.03[b]
EC	6.10±0.02 [a]
FC	6.10±0.02 [a]
GC	6.10±0.02[a]

Values are presented as mean± standard deviation of replicate determinations (n=3). Means with different superscripts within the same column were significantly ($p\leq0.05$) different.

KEY: Control = 100% condensed milk; AC = Condensed milk: Coconut (90:10); BC = Condensed milk: Groundnut (90:10); CC = Condensed milk: Tiger nut (90:10); DC =Condensed milk: Coconut: Groundnut (80:10:10); EC = Condensed milk: Tiger nut: Groundnut (80:10:10); FC = Condensed milk: Coconut: Tiger nut (80:10:10); GC = Condensed milk: Coconut: Tiger nut: Groundnut (70:10:10:10)

Table 4 shows the mean sensory scores of condensed milk candy samples enriched with coconut, tiger nut and groundnut, as evaluated by semi-trained panellists (n=27). Mean scores showed that candy samples were not totally different ($p<0.05$) from each other in terms of all sensory attributes evaluated by the panellists. The minimal mean score recorded was 7.04 while the maximal was 8.73 on a scale of 9.0

Table 4: Mean sensory scores of condensed milk candy enrich with coconut, tiger nut and groundnut

Sample	Colour	Aroma	Texture	Taste	Mouthfeel	Overall Acceptability
Control	7.74±0.02 [ab]	7.85±0.02 [ab]	7.26±0.01[a]	8.04±0.02[ab]	7.70±0.02[ab]	8.33±0.02[b]
AC	7.81±0.02 [ab]	8.11±0.02[ab]	7.85±0.02[b]	7.89±0.02[ab]	8.11±0.02[b]	8.73±0.02[ab]
BC	7.89±0.02 [ab]	7.70±0.02[b]	7.59±0.02[ab]	7.89±0.02[ab]	7.89±0.02[ab]	8.26±0.02[b]
CC	7.15±0.01[a]	7.26±0.01[a]	7.41±0.02[ab]	7.33±0.01[a]	7.48±0.01[a]	7.74±0.01[a]
DC	7.70±0.02[ab]	7.74±0.02[b]	7.96±0.02[b]	8.07±0.02[b]	8.00±0.02[ab]	8.37±0.02[b]
EC	7.63±0.02[b]	7.26±0.01[a]	7.19±0.01[a]	7.52±0.02[ab]	7.74±0.02[ab]	8.00±0.02[b]
FC	7.37±0.01[a]	7.70±0.02[b]	7.07±0.01[a]	7.74±0.02[ab]	7.59±0.01[a]	8.04±0.02[ab]
GC	7.63±0.02[b]	7.37±0.01[a]	7.22±0.01[a]	7.78±0.02[ab]	7.63±0.01[a]	8.15±0.02[ab]

Values are presented as mean± standard deviation of replicate determination (n=2). Means with different superscripts within the same column were significantly ($p\leq0.05$) different.

KEY: Control = 100% condensed milk; AC = Condensed milk: Coconut (90:10); BC = Condensed milk: Groundnut (90:10); CC = Condensed milk: Tiger nut (90:10); DC =Condensed milk: Coconut: Groundnut (80:10:10); EC = Condensed milk: Tiger nut: Groundnut (80:10:10); FC = Condensed milk: Coconut: Tiger nut (80:10:10); GC = Condensed milk: Coconut: Tiger nut: Groundnut (70:10:10:10).

Discussion

The moisture contents recorded for the sample agrees with the with the reports of Ergun *et al.* (2010) that moisture content should be between 2-5% for hard candy and for chewable 6-22%. Moisture plays a key role in texture of candies high moisture content in foods such as candy implies adverse effect on storability, stickiness in the packaging material and low moisture makes it to become rock-hard adhesive that welds jaw together which is due to the temperature and time it spent. Temperature also affects the hardness of candy that is why we maintain 95ºC in order not to allow the candy to solidify on time so as to incorporate the tiger nut, coconut and groundnut. Increase in the protein contents of the samples could be attributed to individual levels of protein in the blends. Candy contain no protein (FatSecret, 2022) but by enrichment with plant-based milk, protein content could improve. This could imply that improvement in protein content depends solemnly on type and variety of candy. Fat are high in calories, food that are made mostly of sugars do not contain any vitamins or minerals are called 'empty calorie' foods (UMass, 2022). By enriching the candies, it boosts the vitamin and mineral making it a healthy food. Slight increase in the ash content could be attributed to the enrichment with tiger nut and groundnut. Thus, possible explanation for this increase is that a lot of mineral elements present in tiger nut and groundnut (Ref). Crude fibre, the digestible part of foods varied between 0.64-1.41% with EC (80:10:10) having the highest value. The addition of tiger nut and groundnut spikes the increase in the fiber content which is due to the fact that the two are rich in fiber. The values obtained are within the recommended range for diets of not more than 5g dietary fiber per 100 g dry matter (FAO/WHO, 2003). Carbohydrate contents of 68.48-82.98% were obtained. Candy produced from 90% condensed milk and 10% groundnut had the highest value of carbohydrate while candy produced with 70% condensed milk, 10% coconut, 10% tiger nut and 10% groundnut had the least value (68.48%). However, the carbohydrate contents in this present work are lower than that obtained in a previous work, which ranged from 90.55-91.73% in the candies produced from tiger nut and melon milk (Obasi & Ugwe, 2015) but was in accordance with (43.3 g/100 g) (USDA, 2018).

Teshome *et al.* (2015) reported a pH value ranging from 6.07-6.67 in a similar work on the chemical and physical quality of raw cow's milk. According to WHO (2006), exposure to extreme pH >11 result in irritation in eyes, skin and mucous membrane and cause hairs fibre to swell in humans. Also, low pH results in the same effects with the severity of which increases with decreasing pH.

Colour is a major criterion affecting the quality of heated food products containing sugar. Colour is a key important factors which can significantly influence customers purchase decision which may be due to the higher level of pigmented materials such as polyphenols in the raw materials (Singh & Muthukumarappan, 2008). For process condense milk candy colour plays an important role, temperature and time is the key determinant. The aroma of the candies showed significant differences with sample BC having the highest score of 8.11 and sample E with the least score of 7.26. The result showed that sample DC had the best taste with score of 8.07. Onyekwelu (2018) reported mean scores ranging from 5.60-7.80 in similar work on chemical composition and sensory evaluation of candies from tiger nut and coconut blends. Mouthfeel is also sometimes referred to as texture according to Dollase and Jurgen (2005). The overall acceptability as revealed by the results of the panelist showed that samples AC and DC have the highest scores of 8.37, hence highly prepared by the consumers.

CONCLUSION

The result of this study shows that acceptable candies can be produced from condensed milk with the inclusion of coconut, tiger nut, and groundnut at different levels. The pH of the candies was less acidic in nature (6.02-6.10). With the finding, an increase in the utilization of tiger nut is possible and this would encourage more cultivation of the crop, and income generation is feasible for the farmers. Ultimately, there is value addition on the part of tiger nut.

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