Quality and Nutritional Contents of Cocoyam and Wateryam Balls (Ekpang Nkukwo) Supplemented with Soybean and Melon Seeds

Udobong, Etebong Gabriel
Department of Home Economics Education
Akwa Ibom State College of Education, Afaha Nsit, Nigeria
Corresponding Email: bankross@gmail.com

Abu, J.O.
Department of Food Science and Technology,
University of Agriculture, Makurdi, Benue State, Nigeria

George, Williams Kennedy
Department of Technical Education
Akwa Ibom State College of Education, Afaha Nsit, Nigeria
https://orcid.org/0009-0007-4207-834X
Email: georgekennedyresearchers@gmail.com

DOI: 10.56201/ijee.v10.no2.2024.pg219.229

Abstract
This study examined the potential enhancement of Ekpang Nkukwo supplemented with soybean and melon seeds, aiming to improve its quality and nutritional contents. The experiment involved supplementing Ekpang Nkukwo with soybean and melon seed flours at 10%, 15%, and 20% concentrations and evaluating their effects on proximate composition and sensory acceptance. The sensory properties of Soybean and melon flour supplement general acceptance ranges from 5.93 to 7.13. Proximate composition analysis revealed significant changes in various nutritional parameters with increasing supplementation levels. Ash content increased from 1.86% to 2.36%, while crude protein content ranged from 6.20% to 10.46%, fat content from 8.23% to 12.64%, and energy content from 189.23 kcal to 226.96 kcal (p<0.05). Conversely, moisture content decreased from 60.74% to 56.19%, and carbohydrate content decreased from 22.59% to 17.84% as supplementation levels increased (p<0.05). Interestingly, crude fiber content increased slightly from 0.38% to 0.51%, showing no significant differences (p>0.05). These findings suggest that supplementation with melon seed flour can enhance the sensory appeal of Ekpang Nkukwo while simultaneously improving its nutritional value. The findings contribute to the diversification of food products, offering healthier alternatives without compromising cultural authenticity. Hence, the researchers recommended that food scientists, nutritionists, agriculturists, policymakers, and product developers should adopt this approach to enhancing the quality and nutritional content of Ekpang Nkukwo.

Keywords: *Ekpang Nkukwo, Cocoyam, Wateryam, Soybean, Melon Seeds, Sensory Evaluation, Proximate Analysis, Nutritional Value.*

Introduction

Malnutrition remains a significant public health concern in Nigeria, affecting a considerable portion of the population experiencing deficiencies in nutrients (Ijarotimi et al., 2016; Akombi et al., 2017). The prevalence of malnutrition is exacerbated by the widespread consumption of monotonous diets and limited access to nutrient-rich foods, particularly impacting vulnerable groups such as children and expectant mothers (Akanbiemu, 2014; Adeyonu, 2022). Addressing this issue has prompted a growing demand for high-quality, nutritious foods, sparking discussions on the Food Industry's role in promoting healthy and sustainable dietary choices (Buttriss, 2013). Traditional foods play a vital role in both cultural heritage and nutritional sustenance, reflecting the culinary customs of diverse communities. One such example is Ekpang Nkukwo, a traditional dish hailing from Akwa Ibom and Cross River States in Nigeria, which embodies a rich culinary legacy (Ani et al., 2012). Ekpang Nkukwo is often enjoyed as a main course, complemented with protein-rich elements like fish or meat. It holds significant cultural value, cherished for its flavorful taste and its role in fostering communal bonds during celebrations and gatherings. The preparation of Ekpang Nkukwo involves blending mashed cocoyam and wateryam, shaping them into balls, and wrapping them in fluted pumpkin leaves before cooking with palm oil, salt, crayfish, onions, and seasoning cubes (Enwere, 1998). This traditional dish not only satisfies hunger but also serves as a symbol of cultural identity and unity within communities.

Cocoyam (Colocasia esculenta) is a widely recognized carbohydrate-rich food plant belonging to the Araceae family (Okpala, 2013; Awolu, 2016). Encouraging the utilization of cocoyam and water yam presents opportunities for enhancing food security in regions where cocoyam is cultivated (Ukpabi et al., 2008). Africa accounts for approximately 75% of global cocoyam production, with Nigeria and Ghana being the leading producers (Ojo et al., 2022). In Nigeria, cocoyam ranks as the third most important root and tuber crop after yam and cassava, often consumed by low-income groups due to its affordability (Olayiwola et al., 2013; James, Charles & Joel, 2013; Ibanga, 2023). Cocoyam, characterized by its starchy consistency, exists in two primary varieties: a soft version commonly used for thickening soups and a yam-like variant that can be quickly boiled and served with pepper sauce (Udo, 2022). The soft type is predominantly utilized in Nigerian cuisine for soup thickening purposes. Water yam (Dioscorea alata), on the other hand, is distinguished by its irregular shape and dark to black outer skin, with a bright purple or creamy white flesh (Sobowale et al., 2017). Its high-water content gives rise to its name 'water yam.

Cocoyam stands out as a nutritionally superior option among root and tuber crops (Ojinnaka & Nnorom, 2015). It boasts a higher crude protein content compared to other crops in this category, and its starch granules are notably small, enhancing digestibility. Furthermore, cocoyam is rich in essential nutrients including calcium, phosphorus, vitamin A, and B-vitamins (Kabuo, 2018). Despite these nutritional benefits, cocoyam remains largely underutilized in Nigeria, primarily confined to subsistence-level cultivation, rendering it a significantly neglected crop (Amadi, 2017). In the South Eastern region of Nigeria, cocoyam flour is frequently employed as a thickening agent in soup preparation. Studies have indicated that cocoyam consumption can lead to a reduction in blood glucose levels, underscoring its potential anti-hyperglycemic properties and advocating its use for diabetic individuals (Folasire, 2016). Recognizing its nutritional and chemical composition, cocoyam holds promise for enhancing food and nutrition security, particularly in tropical regions (FAO, 2006). However, despite its cultural significance and appealing taste, traditional dishes like Ekpang Nkukwo may not fully meet contemporary dietary requirements in terms of nutritional adequacy. To address this concern, there is potential for enriching such traditional foods by incorporating locally available ingredients such as soybean and melon seeds, thereby enhancing their nutritional profile and relevance to modern dietary needs.

Soybean (Glycine max) is a leguminous plant widely cultivated for its versatile and nutritious seeds. The seeds of soybean possess exceptional nutritional and functional properties, making them highly valued in various applications. Renowned for their nutrient-rich composition, soy-based foods are recognized for their health-promoting attributes (Peter-Ikechukwu, 2019). Soybeans stand out as the sole plant source encompassing all essential amino acids, with a protein content surpassing that of other legumes. Moreover, soy protein boasts high quality and digestibility. Rich in fats, soybeans predominantly contain unsaturated fatty acids, with polyunsaturated (primarily linoleic acid), monounsaturated (oleic acid), and saturated (primarily palmitic acid) fats constituting approximately 63%, 23%, and 14%, respectively. Notably, soybeans are particularly abundant in polyunsaturated fats, including essential omega-3 fatty acids such as alpha-linolenic acid. In addition to proteins and fats, soybeans are abundant in various vitamins and minerals, including B-vitamins, calcium, iron, and phosphorus (Peter-Ikechukwu, 2019). They also harbor antioxidants and phytonutrients like phytosterols and phytoestrogens, associated with diverse health benefits. Soybean emerges as an economically feasible and highly nutritious source of plant protein, holding the potential to address widespread nutritional deficiencies. Apart from its protein content, soybean is esteemed for offering unparalleled nutritional value among plant-based foods globally (Peter-Ikechukwu, 2019). With a protein content ranging from 35% to 45%, soybeans also contain substantial amounts of oil (15–25%) and carbohydrates, with approximately 33% composition, including 16.6% soluble sugars (Hou, 2009). Additionally, soybeans contain around 19.10% ether extract, 5.71% crude fiber, 5.06% mineral content, and 26.05% nitrogen-free extract (Ogundele, 2015).

Incorporating soybean and melon seeds into Ekpang Nkukwo aligns with the principles of sustainable food systems and local food sovereignty. By utilizing indigenous ingredients, this practice not only fosters agricultural diversity but also bolsters local economies and diminishes reliance on imported foods. Moreover, supplementing traditional dishes with nutrient-rich local crops enhances food security by offering accessible and cost-effective sources of vital nutrients. Achieving an optimal balance of cocoyam, wateryam, soybean, and melon seeds to maximize nutritional benefits while preserving sensory characteristics necessitates careful formulation and processing techniques. Additionally, ensuring the bioavailability of nutrients and addressing potential consumer acceptance concerns are vital aspects in promoting the adoption of these supplemented variants of Ekpang Nkukwo as nutritious dietary choices. Despite the potential advantages of supplementation, there is a paucity of research investigating the feasibility and effectiveness of integrating soybean and melon seeds into Ekpang Nkukwo. Thus, this study aims to explore the feasibility of enriching the nutritional content of Ekpang Nkukwo through supplementation with soybean and melon seeds, aiming to enhance its nutritional value while upholding its sensory attributes and cultural authenticity.

MATERIALS AND METHODS

Materials Procurement:

Cocoyam (*Colocasia esculenta*) and wateryam (Dioscorea alata) tubers were purchased from Uyo central market in Akwa Thom State. Soybean variety (TGX1485-ID) was obtained from the National Cereals Research Institute (N.C.R.I) Yandev. Gboko Local Government Area, Benue State, whereas melon was purchased from Modern Market, Makurdi, Benue State.

Methodology

Preparation of Cocoyam or Wateryam Mash

Five kilograms of cocoyam or wateryam tubers were manually peeled with knife and then washed with clean potable water. They were cut into slices of about 0.8cm thick to expose large surface area and blanched in hot water at 90°C for 1.5min before grating (Balami *et at.,* 2004).

Preparation of Soybean Flour

Five kilograms of soybean seeds free from foreign materials such as stones and leaves were boiled for 30min. they were then dehulled manually and washed with cold water to remove the hulls. The dehulled soybeans were dried in an oven at 602^{o}C for 10–12h. The dried soybean seeds were ground using electrically powered blender (Holstar, BE 768-2, China) into flour. The resultant flour was sieved to a particle size of 500m and packaged in polyethylene bags (Akpapunam, 2004).

Preparation of Melon Flour

Five kilograms of manually dehulled kernels were blanched by putting them in a plastic basket and exposing them to saturated steam of 90–95^{o}C for 5min. The blanched melon kernels were dried in an oven at 60^{o}C for 9h. The dried melon kernels were ground using eclectically powered blender (Holstar, BE 768-2, China) into flour. The resultant flour was sieved to a particle size of 500m and packaged in polyethylene bags (Chinma, 2005).

Preparation of “Ekpang Nkukwo”

Fig. 1 shows the flow chart for the preparation of “Ekpang Nkukwo” product.

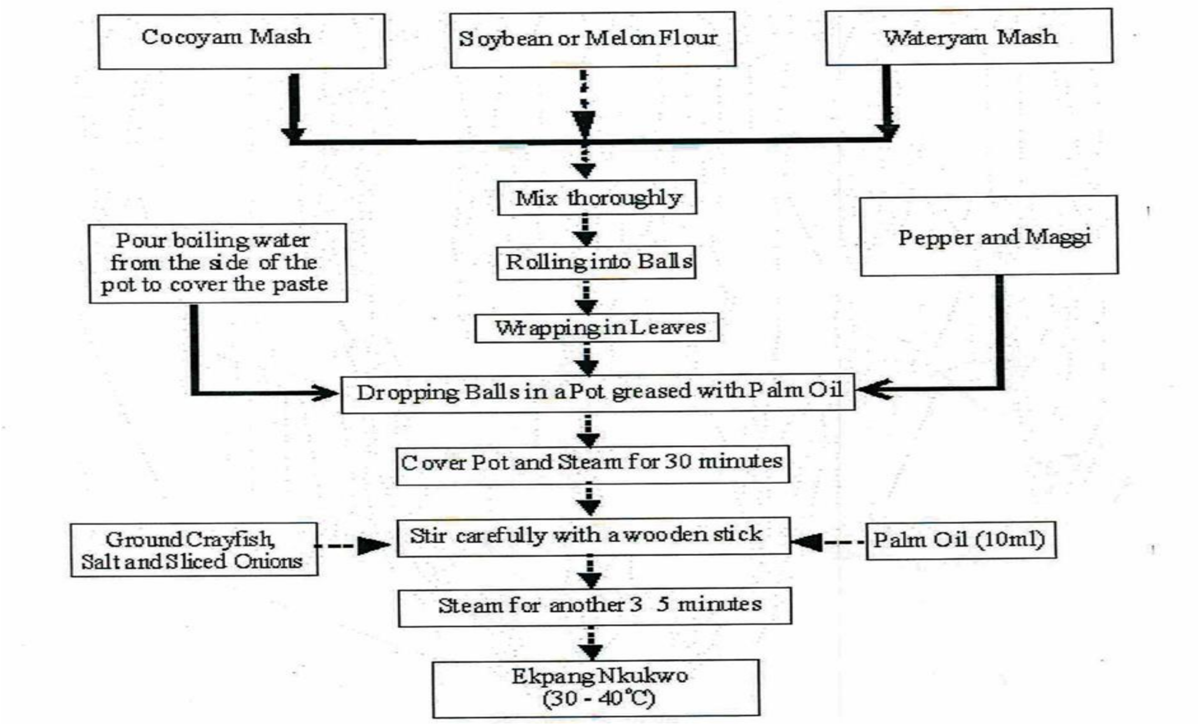

Figure 1: Flow chart for the preparation of "Ekpang Nkukwo" dish

Sensory Evaluation

Warm "Ekpang Nkukwo" were coded and served to 15 semi-trained panelists. The panelists were given enough water to rinse their mouths between each sample. The attributes evaluated include colour/appearance, taste, flavor, texture and general acceptability on a nine (9) point hedonic scale where 9 was liked extremely and 1 disliked extremely. The data collected were subjected to statistical analysis of variance (ANOVA).

Analysis of Proximate Composition

Moisture content, carbohydrate content, crude protein, fat, ash and crude fiber were all determined according to AOAC (1995). Energy content was determined according to the prescribed method (Osborne & Voogt, 1978).

RESULTS AND DISCUSSION

Sensory and Proximate Analysis of Cocoyam and Wateryam

The functional properties, sensory attributes, and proximate analysis of cocoyam reveal its versatile culinary and nutritional potential. The results of the mean scores of Ekpang Nkukwo produced from undefatted soybean flour and melon flour is shown in Table 1 and 2. There were significant differences (p0.05) in taste, texture and general acceptability from blends of Ekpang Nkukwo.

Sensory Analysis of Cocoyam and Wateryam

Sensory analysis of cocoyam and wateryam provides valuable insights into their organoleptic qualities, guiding their utilization in culinary practices and food product development. Cocoyam, with its earthy flavor and starchy texture, is often evaluated for attributes such as taste, aroma, color, and texture, which influence its acceptability in various dishes. Similarly, wateryam, characterized by its mild taste and smooth texture, undergoes sensory evaluation to assess its palatability and suitability for different culinary applications. Understanding the sensory profiles of cocoyam and wateryam enables chefs, food processors, and product developers to optimize their incorporation into recipes and food formulations, ensuring the creation of flavorful and appealing dishes that resonate with consumer preferences. Table 1 shows the effect of soybean and melon flour supplement on the sensory properties of Ekpang Nkukwo.

Table 1: Effect of soybean and melon flour supplement on the sensory properties of Ekpang Nkukwo

Sample Code	Colour/Appearance	Taste	Flavor	Texture	General Acceptance
b1	7.27^{ab}	6.47^{a}	6.53^{ab}	7.20^{a}	7.13^{a}
b2	7.60^{a}	$6.8o^{a}$	7.20^{a}	7.27^{a}	6.80^{a}
b3	6.33^{b}	6.47^{a}	6.93^{a}	6.67^{ab}	6.53^{b}
b4	6.27^{b}	6.40^{a}	6.20^{ab}	6.29^{b}	6.40^{a}
bs	6.40^{b}	5.53^{a}	5.73^{b}	6.47^{ab}	5.93^{a}
LSD	1.16	-	1.17	1.00	-

Means with the same (letter) superscripts in a column are not significantly difference

key:
b_1 = 50g Cocoyam Mash + 30g Wateryam Mash + 20g Melon Flour “Ekpang Nkukwo”
b_2 = 55g Cocoyam Mash + 30g Wateryam Mash + 15g Melon Flour “Ekpang Nkukwo”
b_3 = 60g Cocoyam Mash + 30g Wateryam Mash + 10g Melon Flour “Ekpang Nkukwo”
b_s = 70g Cocoyam Mash + 30g Wateryam Mash + “Ekpang Nkukwo” reference sample

In all sensory attributes evaluated, “Ekpang Nkukwo” supplemented with melon flour were rated higher and acceptable. However, Ekpang Nkukwo produced from 50:30:20 (b_1) (CWM), and 55:30:15 (b_2) (CWM), had the best rating in terms of overall acceptability. The results show that “Ekpang Nkukwo” supplemented with melon flours were highly rated by panelists in terms of appearance (colour), taste, flavours and texture. This agreed with published works of Ojo, et al. (2022) for sensory properties of the amala dumpling from the blends of cocoyam and soybean flours at 30% caused significant difference in the texture of the *amala* dumpling prepared from the blends of cocoyam and soybean flours with 15% level of soybean substitution appeared to be more acceptable to the panelist.

Proximate Analysis of Cocoyam and Wateryam

Proximate analysis of cocoyam and wateryam involves assessing their nutritional composition, providing essential information for dietary planning and food formulation. Cocoyam, rich in carbohydrates and dietary fiber, serves as a valuable source of energy and promotes digestive health. Additionally, cocoyam contains moderate levels of protein and negligible amounts of fat, contributing to its nutritional value. Wateryam, characterized by its high-water content and lower carbohydrate content compared to cocoyam, offers hydration and satiety while providing essential vitamins and minerals. Proximate analysis of both cocoyam and wateryam informs their utilization in diverse culinary applications and aids in promoting balanced and nutritious diets. The results of the proximate analysis of most acceptable "Ekpang Nkukwo" blends are shown in Table 2.

Table 2: Proximate analysis of most acceptable "Ekpang Nkukwo" blends.

Sample Code	**Moisture %**	**Ash %**	**Crude Protein %**	**Crude Fibre %**	**Fat %**	**Carbohydrate %**	**Energy Content (kcal/100g)**
b_1	$56.19^a\pm0.02$	$2.36^a\pm0.09$	$10.46^a\pm0.20$	$0.51^a\pm0.01$	$12.64^a\pm0.01$	$17.84^a\pm0.01$	$226.96^a\pm0.49$
a_1	$59.40^b\pm0.01$	$2.13^b\pm0.09$	$8.60^b\pm0.01$	$0.42^b\pm0.00$	$10.24^b\pm0.02$	$19.21^b\pm0.02$	$203.40^b\pm0.30$
b_2	$60.74^a\pm0.04$	$1.86^a\pm0.04$	$6.20^a\pm0.21$	$0.38^a\pm0.01$	$8.23^a\pm0.03$	$22.59^a\pm0.23$	$189.23^a\pm0.24$
LSD	0.02	0.21	0.21	-	0.06	0.21	1.53

Means with the same (letter) superscripts in the same column are not significantly difference ($p\geq0.05$).

Key:
b_1 = C:W:M – 50g Cocoyam Mash: 30g Wateryam Mash: 20g Melon Flour
a_4 = C:W:M – 55g Cocoyam Mash: 30g Wateryam Mash: 15g Melon Flour
b_2 = C:W:M – 60g Cocoyam Mash: 30g Wateryam Mash: 10g Melon Flour
LSD = Least Significant Difference

Moisture content ranged from 56.19 to 60.74% with significant (p0.05) differences. Also, there was a reduction in moisture content values with increasing level of melon flour. The high moisture contents of "Ekpang Nkukwo" products are an indication of high moisture contents of cocoyam and wateryam mashed. Ash content varied from 1.86 to 2.36%. Ash content of "Ekpang Nkukwo" sample product increased with increasing level of melon flour with significant (p0.05) differences. The slight increase in ash content among samples blend may be due to addition effect. Protein contents of "Ekpang Nkukwo" ranged from 6.20 to 10.40%. Protein content of Ekpang Nkukxso samples product inacad with increasing level of melon flour with significant (p0.05) differences. They increase in protein content may be due to addition effect and heat treatments such as cooking. However, under heat treatment such as frying, the nutritional value of oil seed proteins is usually increased (Mercier, 1993). Crude fiber content of "Ekpang Nkukwo" ranged from 0.38 to 0.51%. Crude fiber content of "Ekpang Nkukwo" samples product increased with increased level of melon flour with no significant (p0.05) difference. However, crude fiber content of oil seeds was not reported in available literature for comparison. Fat content of "Ekpang Nkukwo" ranged from 8.23 to 12.64%. Fat content of "Ekpang Nkukwo" samples product increased with increasing level of melon flour with significant (pO.OS) differences.

Increase in fat content of "Ekpang Nkukwo" balls may be due to high uptake of palm oil during cooking with respect to difference moisture content of the mash (McWalters & Hung, 1995). Carbohydrate content of "Ekpang Nkukwo" sample product varied from 17.84 to 22.59% Carbohydrate content of "Ekpang Nkukwo" samples product decreased with increasing level of melon flour with significant (p0.05) differences. Reduction in carbohydrate content could be as a result of cooking effect. However, frying has been reported to lower carbohydrate content of legume products and snack supplemented with oil seed flour (Akubor et al., 2000; Lasekan & Akintola, 2003). Energy content of "Ekpang Nkukwo" samples product increased with increasing level of melon flour with significant (p0.05) differences.

Conclusion

In this study, the researchers delved into the potential of enriching the nutritional composition of Ekpang Nkukwo, a traditional Nigerian delicacy, by incorporating soybean and melon seeds. Despite being emblematic of cultural heritage and culinary tradition, traditional foods like Ekpang Nkukwo often lack the nutritional adequacy required for contemporary dietary needs. Tackling this challenge necessitates innovative strategies that strike a balance between nutritional enhancement and the preservation of cultural authenticity and sensory appeal. The results of the study demonstrated the practicality and effectiveness of supplementing Ekpang Nkukwo with soybean and melon seeds to elevate its nutritional profile. Through a thorough analysis of proximate composition, notable increases in key nutrients such as protein, fat, and energy content were observed with escalating levels of supplementation. By harnessing native crops, we not only foster agricultural variety but also bolster local economies and reduce dependence on imported food items. Moreover, the practice of enriching traditional dishes with nutrient-rich elements resonates with the ethos of sustainable food systems, offering eco-friendly solutions to combat malnutrition and food insecurity.

Recommendations

The researchers recommended that a comprehensive approach involving food scientists, nutritionists, agriculturists, policymakers, and product developers is essential to enhance the quality and nutritional value of Ekpang Nkukwo. They recommended leveraging their diverse expertise and resources through the following strategies:

1. Identify and promote cultivars of cocoyam and wateryam that are rich in nutrients, ensuring they possess desirable culinary qualities suitable for preparing Ekpang Nkukwo.
2. Develop and disseminate improved processing methods to preserve maximum nutritional content during the preparation of Ekpang Nkukwo, including techniques to minimize nutrient loss during cooking.
3. Educate consumers about the nutritional advantages of Ekpang Nkukwo supplemented with soybean and melon seeds, emphasizing its potential to enhance dietary diversity and combat malnutrition.
4. Advocate for policies that bolster the production and consumption of nutritious traditional foods like Ekpang Nkukwo, including incentives for farmers, subsidies for agricultural inputs, and regulatory measures to ensure food safety.
5. Facilitate market access for Ekpang Nkukwo producers by establishing connections with local markets, retailers, and food service providers, and exploring export opportunities where feasible

Acknowledgements

Dr. Ingbian's extensive knowledge, constructive input, motivation, steadfast dedication, and pursuit of excellence have played a pivotal role in influencing the trajectory and results of this study. As a result, the researchers express their sincerest gratitude and profound appreciation to Dr. Ingbian, E.K., whose steadfast support and mentorship have been indispensable throughout the duration of this research endeavor.

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