Research Article

Variations in Nutrients Composition of Most Commonly Consumed Cassava (*Manihot esculenta*) Mixed Dishes in South-Eastern Nigeria

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Variations in nutrient composition of most commonly consumed cassava (*Manihot esculenta*) mixed dishes in South-eastern Nigeria were determined. Four communities were randomly selected from each of the five states in the South-east. Focus group discussions (FGD) were conducted in each of the communities to determine commonly consumed foods and variations in recipes. 24-Hour dietary recall was conducted using 50 randomly selected households in those communities. Recipes collected during the FGD were standardized, prepared, and chemically analysed using standard methods. Data were analysed using descriptive statistics. Cassava-based dishes were the most commonly consumed in South-eastern Nigeria. Ninety-two percent of the study population ate cassava either in form of “fufu” (fermented cassava meal)/garri (fermented and roasted cassava meal) with soup or as “abacha” (tapioca salad). Commonly consumed soups were melon (*Citrullus vulgaris*) seeds, “ora” (*Pterocarpus soyauxii*), and vegetable soups. Seven melon seed, six “ora,” and four vegetable soups and five “abacha” variations were identified. Except for vegetable soup, coefficient of variation for moisture was <10%, while large variations (19–71%) were observed for energy and nutrients. These variations in cassava-based dishes need to be reflected in the country-specific food composition database to enable nutrient intake assessment or provision of dietary guidance using such food composition database as a reference material to be more effective.

1. Introduction

The need for good quality food composition data on commonly consumed dishes cannot be overemphasized. They are needed for a variety of purposes. For the nutritional epidemiologist, food composition data are used to estimate nutrient intakes of individuals or population groups in order to establish diet-disease relationships [1]. They are used for establishment of dietary goals [2], while the dietitian employs them for dietary counselling [1]. Inaccurate data will lead to overestimation or underestimation of dietary intakes.

Foods can be consumed as single foods or as mixed dishes/multi-ingredient foods and as such any comprehensive food composition database or table should contain the nutrient composition of foods as consumed by the population it serves. The nutrient composition of foods varies as a result

of several factors. For single foods, nutrient variability has been attributed to inherent (age, maturity, genus, species, variety, and cultivar), environmental (soil, climate, pesticides, etc.), and processing (cooking methods, preservation methods, etc.) factors. However, for mixed dishes or multi-ingredient foods, the causes are much more complex [3].

Studies have shown that most commonly consumed traditional mixed dishes in Nigeria differ in several ways depending on the socioeconomic status of the family food provider, the prevailing food taboos, food prices, cultural and religious practices, level of nutritional knowledge, and food availability and seasonality [4, 5]. Variations in Nigerian local dishes are also due to the different ingredients (with different composition) used in preparing them, for example, type and quantity of animal protein, type of cooking oil, type of thickening agent, use of vegetables, and use of

potash and seasoning/flavouring agents [6]. These mixed dishes vary from simple (few ingredients) to very complex (many ingredients) ones. Holden [7] noted that a particular product can have 1–30 different ingredients. According to Vasilopoulou et al. [8], composite dishes show the greatest variations and, therefore, represent the least reliable data in food composition database.

Variation can be defined as deviation from a central position or value. Measures of nutrient variability are useful not only to database compilers, food analysts, and food manufacturers but also to dietitians, nutritionists, and researchers who use food composition database to plan and evaluate the diets of patients and clients with modified diets [9]. In this situation, dietitians seek for mean values of nutrients in foods. The presence of a measure of nutrient variability such as standard deviation (SD) or coefficient of variation (CV) can be very useful to nutrition professionals to assess the reliability of mean values and provide practical dietary advice and guidance [3]. Measurement of nutrient variability is of particular importance if it occurs in foods that are relied upon as major sources of nutrients for a specific population. Therefore, determining the nutrient variability in commonly consumed Nigerian dishes is a right step towards the development of a comprehensive, country-specific nutrient database that can be used to obtain good estimate of the dietary intake of individuals and/or population groups.

2. Materials and Methods

2.1. Area of the Study. The study was carried out in the South-east geopolitical zone of Nigeria. The zone comprises Anambra, Enugu, Abia, Imo, and Ebonyi states. It lies between the North-central and South-South zones of Nigeria. The South-east zone is the home of the Ibos with a total land area of about 158,000 square miles (about 41,000 sq km). The Ibo population is estimated to be about 18 million [10].

Apart from trading, which is an old occupation among the Ibos, the traditional Ibo economy depends largely on root-crop farming where yam, cassava, and taro are the chief root crops. Hence, a typical Ibo meal includes a starch and a soup/stew prepared with vegetables to which pieces of fish, beef, goat, or other animal food sources are added.

Presently, an increasing number of Ibos engage in wage labour. Growing cities, expanding roads, construction of new industries, and oil exploration are creating many job opportunities.

2.2. Study Design. A cross-sectional survey was adopted for food/recipe documentation, while quasi-experimental design was adopted for recipe harmonization/standardization and food analysis as well as dietary evaluation.

2.3. Study Population. The population for this study consisted of all the communities in South-east geopolitical zone of Nigeria.

2.4. Study Sample. Stratified sampling technique that involved two stages of purposive sampling and one stage of randomization was used. South-east zone was grouped

into three clusters differing considerably in terms of food production and consumption pattern. The three clusters formed three strata based on similarities as follows: (1) Anambra/Enugu, (2) Abia/Imo, and (3) Ebonyi. In the first stage, four Local Government Areas (LGAs) were purposefully selected from each of the first two strata (Anambra/Enugu and Abia/Imo) and two were selected from the last stratum (Ebonyi). In the second stage, two communities were also purposively selected from each of the chosen LGAs (one urban and rural community). This implies that the documentation exercise was carried out in ten LGAs and in twenty communities in the study area. In the third stage, women were randomly selected from their clusters in each of the community's major market for the 24-hour dietary recall. One in every three women in each cluster was selected until the required number was obtained.

2.5. Data Collection

2.5.1. 24-Hour Dietary Recall. Food intake pattern at household level was determined with the use of 24-hour dietary recall. The 24-hour dietary recall was conducted on 50 randomly selected women representing 50 households in the community making a total of 1000 women/households. The information so gathered was used to produce food consumption statistics (list of foods/dish and frequency of consumption by families). From the food consumption statistics, the most frequently consumed foods/dishes were identified. The data presented in this study are based on the most commonly consumed food/dishes in each of the selected communities.

2.5.2. Focus Group Discussion. The focus group discussion was used for documenting the recipes of the commonly consumed dishes and also to validate the information gathered from the consumption survey. The focus group discussion was conducted in all the selected communities. It comprised small groups of about 6–8 adult women selected with the help of community based facilitators. Each session lasted for 45–60 minutes. The commonly consumed dishes, as obtained from the food consumption statistics and a form containing all the food groups, served as the focus group discussion guide. Recipes of the commonly consumed dishes, their variations, and traditional methods of preparations were the major points supplied by the focus group.

2.5.3. Recipe Standardization. The recipes collected were standardized using a modified National Food Service Management Institution (NFSMI) [11] method. According to NFSMI, a recipe standardization process can be summarized in three phases: recipe verification, product evaluation, and quantity adjustment. In this study, the two major stages of recipe verification phase (recipe review and recipe preparation) were particularly of interest. Recipe harmonization stage, though not part of recipe verification phase, was included in the study due to its relevance.

(a) Recipe Review. This was done by working on only one recipe at a time to find out if the recipe contained the

following information: (a) recipe title, (b) recipe category, (c) ingredients, (d) weight/volume for each ingredient, (e) preparation instructions (directions), (f) cooking temperature and time, if appropriate, (g) serving size, (h) recipe yield, and (i) equipment and utensils to be used.

(b) *Recipe Harmonization*. Collected recipes of a particular cassava dish were critically examined. Recipes that were significantly different from others in terms of ingredients, quantity, quality, type, and number served as variations. Weights of each ingredient in similar recipes (recipe of a particular dish containing similar ingredients in terms of number, quantity, quality, type, and amount) were collated and harmonized. This involved determining the mean values of each ingredient in each set of similar recipes:

$$\text{mean} = \frac{\text{summation of ingredient weight (g)}}{\text{number of times it (ingredients) occurred}}. \quad (1)$$

(c) *Recipe Preparation*. The standardized recipes of the most commonly consumed dishes were prepared using the traditional method obtained from FGD.

(c1) *Recipe Name*: “Abacha” (*Tapioca Salad*). See Table 1.

Method of Preparation. Fry onion in heated palm oil for a minute and add the seasonings (for variations 1 and 3) or prepare an emulsion with palm oil, potash, and seasons (for variation 2). Add the soaked, washed, and drained cassava chips and mix properly. Serve hot garnished with prawn (for variation 1) or cold garnished with fermented oil bean seed (*Pentaclethra macrophylla*) and garden egg leaves or ukazi leaves (*Gnetum africanum*) (for variation 3). For variations 4 and 5, add soaked, washed, and drained cassava chips, onion, palm oil, and seasonings to the cowpea (boiled till tender), boil for four minutes, stir properly, and serve hot garnished with prawn.

(c2) *Recipe Name*: “Ofe Egusi” *Melon Seed* (*Citrullus vulgaris*) *Soup*. See Table 2.

Method of Preparation. Boil beef till tender seasoning with salt. For variations 2, 4, and 6, melt the ground “ogbono” seed (*Irvingia gabonensis*) in the heated palm oil, add water (for variation 1) or meat and stock (for variations 4 and 6), and bring to boil. For variations 1, 3, and 5, mix “ukpo” (*Mucuna urens*) with palm oil, add to boiling soup water (for variation 1) or boiled meat and stock (for variations 3 and 5), and bring to boil again. Add stock fish head (all the variations) and stock fish (for variation 7) and boil for three minutes. Add melon seeds (gradually to avoid lumping) and bitter leaves (all the variations), “okpei” (*Prosopis africana*) (variations 1 and 2), onion (variations 3–7), smoked fish (variations 1 and 2), pumpkin leaves, crayfish, and seasonings (all the variations). Stir until the mixture becomes homogenous and simmer for five minutes. Serve hot with cassava “fufu” or garri.

(c3) “Ofe Ora” (*Pterocarpus soyauxii*) *Soup*. See Table 3.

Method of Preparation. Boil, peel, and pound cocoyam into paste. Add salt to the beef and boil till it is done. Boil washed

stock fish head for three minutes, add “ukpo” (*Mucuna urens*) mixed with palm oil (for variation 1) or add the stock fish head and the mixed “ukpo” (*Mucuna urens*) to meat and stock (for variations 3 and 5), and boil for five minutes. Add cocoyam paste in balls (for variations 2, 4, and 6) to meat and stock (for variations 4 and 6) or boiling soup water (for variation 2) and boil for five minutes. Add dry fish and boil for another five minutes (for variations 5 and 6). Add smoked fish (for variation 2), “ukazi” leaves (*Gnetum africanum*) (for variation 5), “uziza” leaves (*Piper guineense*), and “ogiri” (*Ricinus communis*) (for variation 6) and palm oil, crayfish “ora” leaves (*Pterocarpus soyauxii*), and seasonings (for all variations). Stir until the mixture becomes homogenous and simmer for three minutes. Serve hot with cassava “fufu” or garri.

(c4) *Recipe Name*: “Ofe Akwukwo” (*Vegetable Soup*). See Table 4.

Method of Preparation. Season raw beef (for variation 3) and ice fish (for variation 4) and boil the beef till it is done. Tie the pumpkin leaves firmly with cord, boil in a potash and water solution for eight minutes, and drain and cut into tiny pieces (for variations 1 and 2). Bring the soup water to boil, add stock fish bone (for variation 1), stock fish head (for variations 2 and 4), boiled meat and stock (for variation 3) or boiled ice fish and stock (for variation 4), and boil for five minutes. Add the precooked pumpkin leaves (for variations 1–2) or sliced raw pumpkin leaves and okra fruits (for variation 3). Add smoked fish and dry fish (for variation 2), garden egg leaves, African spinach, and melon seeds (for variation 4), crayfish (for variations 3 and 4), onion (for variations 1, 2, and 4), palm oil, “okpei” (*Prosopis africana*), and seasonings (for all variations). Simmer for five minutes. Stir to mix well and serve hot with cassava “fufu” or garri.

The prepared dishes were cooled, properly packaged, and taken to the laboratory for chemical analysis. Preparations were done in the Department of Home Science, Nutrition and Dietetics, University of Nigeria, Nsukka.

2.6. *Sample Preparation*. The prepared dishes were homogenised with the use of electric blender. Five grams of each sample was used to determine the actual moisture at 100°C, while the rest were dried at 60°C in an air oven drier, milled, packaged in an air-tight container, and taken stored in the freezer until being ready for chemical analysis.

2.7. *Chemical Analysis*. Protein, moisture (actual and residual), fat, ash, soluble and insoluble dietary fibre, minerals (calcium, magnesium, iron, zinc, sodium, potassium, copper, and phosphorus), and vitamins (A, B₁, B₂, and B₃) were determined according to the method of AOAC [12]. Moisture was determined using the air oven method. Crude protein and fat were determined by Kjeldahl procedure and Soxhlet solvent extraction method, respectively. Dietary fibre (soluble and insoluble) was determined by enzyme gravimetric method of Prosky et al. [13]. Ash was determined by incineration of samples in a muffle furnace at 550°C for six hours. Available carbohydrate was calculated by difference

TABLE 1

Ingredient	Quantity (g) in different variations				
	1 Without vegetable 135 (323)*	2 With vegetable 100 (260)*	3 With vegetable and African oil bean seed 103 (245)*	4 With more cowpea 58 (149)*	5 With less cowpea 375 (962)*
Dry cassava chips	—	—	—	126	167
Cowpea	—	10	—	—	—
“Ukazi” leaves (sliced)	—	—	30	—	—
Garden egg leaves (sliced)	10	—	—	12	20
Dry prawn	25	25	25	25	26
Red palm oil (RPO)	20	—	20	20	35
Fermented African oil bean seed (sliced)	—	—	25	—	—
Fresh pepper (ground)	—	—	—	5	—
Dry pepper (ground)	2	1	2	—	5
Bouillon cube (Knorr)	2	2	2	2	8
Iodized salt (uncle palm)	4	3	5	5	17
Edible potash (ground)	—	1	—	—	—
Nutmeg (ground)	1	—	—	—	—
Water	—	—	—	1500	1600
Yield	340	283	306	560	1560

*Weight of cassava chips after soaking in water; “ukazi” leaves: *Gnetum africanum*; fermented African oil bean seed: *Pentaclethra macrophylla*.

TABLE 2

Ingredients	Quantity (g) in the different variations						
	1	2	3	4	5	6	7
	With smoked fish thickened with "ukpo"	With smoked fish thickened with "ogbono"	With stock fish head thickened with "ukpo" (thick soup)	With stock fish head thickened with "ukpo" (light soup)	With beef and stock fish thickened with "ogbono" (thick soup)	With beef and stock fish head thickened with "ogbono" (light soup)	With beef and stock fish and no thickener
Melon seed (ground)	120	120	150	150	150	150	150
"Ogbono" (ground)	—	15	—	—	15	15	—
"Ukpo" (ground)	10	—	15	10	—	—	—
Bitter leaves (washed & sliced)	100	100	80	80	80	80	50
Pumpkin leaves (sliced)	50	20	20	20	20	20	25
Smoked fish	135	135	—	—	—	—	—
Raw beef	—	—	175	175	175	175	175
Boiled beef	—	—	97	97	99	97	101
Beef stock	—	—	44	79	119	80	175
Stock fish head	—	—	85	85	85	85	100
Stock fish (flesh)	—	—	—	—	—	—	45
Palm oil	50	50	50	50	55	55	30
Crayfish (ground)	7	7	8	8	15	15	9
"Okpei" (ground)	10	6	—	—	—	—	—
Onion	—	—	30	30	30	30	30
Fresh pepper (ground)	10	10	12	12	12	12	12
Bouillon cube (Knorr)	4	6	4	6	4	4	4
Iodized salt (uncle palm)	10	10	17	13	17	17	10
Water	1300	1150	1000	1600	1200	1500	1000
Yield	1322	2258	1355	1679	1454	1560	1073

"Ukpo" : *Mucuna urens*; "ogbono" : *Irvingia gabonensis*; "okpei" : *Prosopis africana*.

TABLE 3

Ingredient	Quantity in different variations of the soup					
	1	2	3	4	5	6
	With stock fish head thickened with "ukpo"	With smoked fish thickened with cocoyam paste	With beef & stock fish head thickened with "ukpo"	With beef and stock fish head thickened with cocoyam paste	With beef, dry fish, & stock fish head thickened with "ukpo"	With beef, dry fish, & stock fish head thickened with cocoyam paste
Ora leaves (shredded)	40	60	90	90	60	60
"Ukpo"	15	—	10	—	20	—
Cocoyam paste	—	150	150	—	—	200
"Ukazi" leaves (sliced)	—	—	—	—	30	—
Smoked fish	—	100	—	—	—	—
Beef (raw)	—	—	95	95	150	150
Boiled beef	—	—	54	47	98	98
Beef stock	—	—	46	73	76	76
Stock fish head	45	—	60	60	93	93
Dry fish	—	—	—	—	88	88
Palm oil	20	30	50	50	100	100
"Uziza" leaves (sliced)	—	—	—	—	—	30
"Ogiri"	—	—	—	—	—	30
Crayfish (ground)	4	5	15	—	12	12
Fresh pepper (ground)	5	5	15	6	10	10
Bouillon cube (Knorr)	2	4	4	4	4	4
Salt	3	5	10	15	15	15
Water	900	900	900	1000	1500	1200
Yield	597	851	750	969	1655	1586

"Ora" leaves: *Pterocarpus soyauxii*; "ukpo": *Mucuna urens*; "ukazi" leaves: *Gnetum africanum*; "uziza" leaves: *Piper guineense*; "ogiri": *Ricinus communis*.

TABLE 4

Ingredient	Quantity (g) of different variations			
	1	2	3	4
	Pumpkin leaves and stock fish bone	Pumpkin leaves, stock fish head, dry fish, & smoked fish	Pumpkin leaves and okra	Spinach and garden egg leaves
Pumpkin leaves	172	210	133	—
Stock fish bone	50	—	—	—
Stock fish head	—	32	—	—
Smoked fish	—	80	—	—
Dry fish	—	26	—	—
Raw beef	—	—	50	—
Boiled beef	—	—	29	—
Beef stock	—	—	76	—
Spinach (sliced)	—	—	—	200
Garden egg leaves (sliced)	—	—	—	70
Melon seed (ground)	—	—	—	26
Okra fruit (sliced)	—	—	70	—
Ice fish (raw)	—	—	—	112
Boiled ice fish	—	—	—	95
Fish stock	—	—	—	30
Palm oil	30	75	37	30
“Okpei” (ground)	30	75	37	30
Crayfish (ground)	—	—	5	5
Onion (sliced)	9	15	—	40
Bouillon cube (Knorr)	4	4	2	4
Dry pepper (ground)	—	—	2	—
Fresh pepper (ground)	4	6	—	4
Edible potash	6	3	—	—
Iodized salt (uncle palm)	4	6	10	7
Water	400	400	300	560
Yield	744	675	490	675

“Okpei”: *Prosopis africana*.

100 – (moisture + protein + fat + ash + dietary fibre). Mineral elements were determined using the Atomic Absorption Spectrophotometer (Perkin-Elmer model 3110, USA). Phosphorus was determined using the vanadomolybdate method. Vitamins were determined using high-performance liquid chromatography (HPLC). All samples were analysed in triplicate. The proximate, mineral, and vitamin values in Tables 5–7 are, therefore, means of three analyses.

2.8. Determination of the Nutrient Content of the Recipes as Consumed. Water conversion factor was calculated using the following formula:

$$\text{WCF} = \frac{100 - \text{actual moisture}}{100 - \text{residual moisture}}. \quad (2)$$

Values obtained through chemical analysis were multiplied with the WCF to obtain nutrient content of the recipes as consumed.

2.9. Statistical Analysis. The data collected were analysed using frequencies, percentages, and means.

3. Results

Focus group discussion (FGD) reports in both urban and rural communities of South-eastern Nigeria revealed that cassava-based dishes were the most commonly consumed. This was confirmed by the 24-hour dietary recall. About 92% of the study population had consumed cassava-based dish 24 hours prior to the time of interview, while about 66% had consumed rice- and yam-based dishes (Figure 1). Other less consumed foods included beans, wheat, breadfruit, plantain, corn, and semovita.

Cassava was generally consumed as “fufu”/garri (see Table 9) with soups. FGD reports from some communities in Enugu and Ebonyi states included tapioca/African salad as another commonly consumed form of cassava. Eleven types of soups were reported from FGD to be the most

TABLE 5: Energy and nutrients composition of “abacha” (tapioca/African salad).

Recipe name	Energy KJ (Kcal)	Moisture (g)	Protein (g)	CHO (g)	Fat (g)	Ash (g)	Dietary fibre (g)	Fe (mg)	Zn (mg)	Ca (mg)	Ph (mg)	K (mg)	Na (mg)	Mg (mg)	Vit. B ₁ (mg)	Vit. B ₂ (mg)	Vit. B ₃ (mg)	Cu
“Abacha” (1)	1099 (263)	53.8	3.68	26.37	14.15	0.87	1.67	0.26	0.07	7.82	10.17	126.67	3.86	14.04	0.03	0.10	1.24	0.08
“Abacha” (2)	781 (187)	61.8	2.21	28.34	5.47	0.97	1.61	0.53	0.06	15.80	60.39	96.73	3.71	14.77	0.32	0.14	1.14	0.50
“Abacha” (3)	849 (203)	56.86	9.40	26.77	5.13	1.27	1.49	0.57	0.16	9.27	117.96	107.45	2.41	22.48	0.32	0.15	1.24	0.61
“Abacha” (4)	728 (174)	62.8	13.50	17.42	3.86	1.44	1.51	0.50	0.41	8.72	80.85	164.36	3.50	22.96	0.31	0.14	1.17	0.56
“Abacha” (5)	636 (152)	65.6	10.45	20.18	1.54	1.23	1.53	0.34	0.27	11.35	60.84	112.54	4.00	13.99	0.26	0.09	0.28	0.10
CV%	19.16	7.07	54.13	19.68	71.10	17.94	7.88	26.84	67.77	26.94	52.87	19.31	16.19	23.54	45.68	19.28	36.44	62.21

(1) “abacha” without vegetable; (2) “abacha” with vegetables and oil bean seed; (3) “abacha” and cowpea with more cowpea; (4) “abacha” and cowpea with more “abacha.” CV%: coefficient of variation.

TABLE 6: Energy and nutrients composition of variations of “egusi” (*Citrullus vulgaris*) soup.

Recipe name	Energy KJ (Kcal)	Moisture (g)	Protein (g)	CHO (g)	Fat (g)	Ash (g)	Dietary fibre (g)	Fe (mg)	Zn (mg)	Cu (mg)	Ca (mg)	Ph (mg)	K (mg)	Na (mg)	Mg (mg)	Vit. B ₁ (mg)	Vit. B ₂ (mg)	Vit. B ₃ (mg)
“Egusi” soup (1)	351 (84)	83	3.43	10.32	2.43	0.52	0.65	0.97	0.06	0.10	31.33	113.07	148.14	12.41	103.02	0.02	0.30	0.04
“Egusi” soup (2)	376 (90)	81.8	3.64	10.85	2.74	0.64	0.66	1.06	0.07	0.11	94.34	122.83	146.04	13.43	113.06	0.03	0.34	0.05
“Egusi” soup (3)	488 (117)	65.8	8.29	19.13	4.81	1.18	1.28	2.01	0.14	0.23	175.74	232.92	273.11	25.64	223.64	0.07	0.63	0.23
“Egusi” soup (4)	307 (74)	84.8	3.29	9.19	1.92	0.47	0.54	0.81	0.03	0.09	77.76	87.57	109.55	10.15	89.45	0.02	0.25	0.09
“Egusi” soup (5)	418 (100)	79.6	4.84	11.5	2.92	0.68	0.75	1.18	0.04	0.13	105.73	131.55	156.08	14.67	133.70	0.05	0.39	0.12
“Egusi” soup (6)	356 (85)	82.6	4.01	9.92	2.48	0.60	0.65	1.00	0.04	0.11	88.16	108.12	123.27	12.39	111.88	0.04	0.32	0.09
“Egusi” soup (7)	612 (146)	70.6	8.41	14.59	4.74	0.97	1.19	1.74	0.06	0.19	145.21	180.67	204.56	21.81	168.45	0.08	0.59	0.20
CV %	32.17	8.53	40.79	28.72	33.95	33.07	37.98	32.94	53.49	33.81	42.24	33.33	30.77	33.43	32.09	45.44	33.83	58.91

(1) “egusi” with smoked/ice fish thickened with “ukpo” (*Mucuna urens*); (2) “egusi” with smoked/ice fish thickened with “ogbono” (*Irvingia gabonensis*); (3) “egusi” with stock fish head thickened with “ukpo” (*Mucuna urens*) (thick consistency); (4) “egusi” with stock fish head thickened with “ukpo” (*Mucuna urens*) (light consistency); (5) “egusi” with meat and stock fish head thickened with “ogbono” (*Irvingia gabonensis*) (thick consistency); (6) “egusi” with meat and stock fish head thickened with “ogbono” (*Irvingia gabonensis*) (light consistency); (7) only “egusi” with stock fish head, meat, and dry/stock fish with no thickener. CV%: coefficient of variation.

TABLE 7: Energy and nutrients composition of variations of “ora” (*Pterocarpus soyauxii*) soup.

Recipe name	Energy KJ (Kcal)	Moisture (g)	Protein (g)	CHO (g)	Fat (g)	Ash (g)	Dietary (g)	Fe (mg)	Zn (mg)	Cu (mg)	Ca (mg)	Ph (mg)	K (mg)	Na (mg)	Mg (mg)	Vit. B ₁ (mg)	Vit. B ₂ (mg)	Vit. B ₃ (mg)
“Ora” soup (1)	206 (49)	89	1.57	7.99	0.70	0.42	0.47	0.59	0.06	0.05	34.43	32.48	13.18	9.16	28.20	0.03	0.21	0.07
“Ora” soup (2)	202 (48)	89.4	1.80	7.34	0.79	0.40	0.47	0.55	0.05	0.04	28.35	29.34	10.81	8.57	27.28	0.02	0.19	0.07
“Ora” soup (3)	223 (53)	88.4	2.28	7.56	0.99	0.45	0.51	0.55	0.06	0.04	42.78	58.34	20.76	9.21	35.84	0.03	0.21	0.08
“Ora” soup (4)	339 (81)	82.2	4.08	11.16	1.38	0.71	0.79	0.91	0.08	0.07	66.99	89.12	32.69	14.98	53.59	0.04	0.35	0.08
“Ora” soup (5)	359 (86)	81.2	4.18	11.86	1.52	0.75	0.91	1.00	0.10	0.08	80.28	105.74	39.01	16.28	64.77	0.05	0.36	0.08
“Ora” soup (6)	380 (91)	80	4.26	13.04	1.45	0.74	0.9	1.02	0.10	0.08	78.92	102.20	38.68	16.58	64.40	0.05	0.36	0.08
CV%	29.13	4.66	38.44	25.27	28.58	27.13	25.39	27.06	26.94	28.07	37.92	45.01	44.59	28.28	34.83	26.62	27.88	4.04

(1) “ora” with crayfish and stock fish head/bone thickened with “ukpo” (*Mucuna urens*); (2) “ora” with crayfish and smoked fish thickened with cocoyam paste; (3) “ora” with crayfish, meat, and stock fish head thickened with “ukpo” (*Mucuna urens*); (4) “ora” with crayfish, meat, and stock fish head thickened with cocoyam paste; (5) “ora” with crayfish, stock fish head, dry fish, and meat thickened with “ukpo” (*Mucuna urens*); (6) “ora” with crayfish, dry fish, stock fish head, and meat thickened with cocoyam paste. CV%: coefficient of variation.

FIGURE 1: Consumption frequencies (in percentage) of foods in urban and rural communities of South-eastern Nigeria obtained from 24-hour dietary recall.

commonly consumed in different urban communities of South-eastern Nigeria. In rural communities, ten types of soups were obtained from FGD report as the most commonly consumed. Among all these, melon (*Citrullus vulgaris*) or “egusi” and “ora” (*Pterocarpus soyauxii*) and vegetable soups were the most commonly consumed in both urban and rural communities.

Tapioca salad (“abacha”) had varied energy and nutrients composition (Table 5). “Abacha” prepared without vegetable (variation 1) had the highest energy (1099 KJ/263 Kcal) and least moisture (54%) content, while “abacha” and beans prepared with more “abacha” (variation 5) had the least energy (636 KJ/152 Kcal) and highest moisture (66%) values. Protein values ranged from 2.2 g in “abacha” prepared with vegetable to 13.5 g in “abacha” and cowpea prepared with more cowpea (variation 4). Carbohydrate value was within the range of 17.4 to 28.3 g, being highest in “abacha” prepared with vegetable (variation 2) and lowest in “abacha” and cowpea prepared with more cowpea (variation 4). A wide variation existed in the fat content of the “abacha” dishes (1.5 to 14.2 g) but the ash and dietary fibre values were comparable (0.9 to 1.4 and 1.5 to 1.7 g, resp.). Phosphorus composition ranged from 10 mg in “abacha” prepared without vegetable (variation 1) to 118 mg in “abacha” prepared with vegetable and oil bean seed (variation 3). Potassium also ranged from 97 mg in “abacha” prepared with vegetable to 164 mg in “abacha” and beans prepared with more beans (variation 4). Magnesium was within 14 mg and 23 mg. Iron, zinc, calcium, and sodium values were low. The vitamin compositions of the “abacha” dishes also varied. Coefficient of variation (CV%) was <10% for moisture and dietary fibre and ranged from 18% to 71% for other nutrients; fat had the highest CV% of 71% followed by zinc (68%), protein (54%), phosphorus (52%), and niacin (46%).

The different variations of melon (*Citrullus vulgaris*) soup (“egusi” soup) varied in energy and nutrients composition (Table 6). Soup variations with moisture content >80% had lower energy (74 Kcal/307 KJ to 90 Kcal/376 KJ) and nutrient

values. Melon soup prepared without thickener (variation 7) had the highest energy and compared favourably with melon soup (variation 3) thickened with “ukpo” (*Mucuna urens*) in fat content (4.7% and 4.8%, resp.), while other variations had fat content ranging from 1.9 to 2.9%. Both variation 3 thickened with “ukpo” (*Mucuna urens*) and variation 7 without any thickener also had the highest protein contents (8.3% and 8.4%, resp.). CV% was lowest for moisture (8.5%) and highest for thiamine (58%) and zinc (53%) values, while others range from 29 to 45%.

Table 7 shows the energy and nutrient content of six variations of “ora” (*Pterocarpus soyauxii*) soup. CV% was least for moisture (4.5%) and thiamin (4%) and highest for phosphorus and potassium (45%) followed by protein and calcium (38%) and magnesium (35%). CV% for other nutrients ranged from 25 to 29%. The protein and all the mineral and vitamin contents of variation 1 of “ora” soup cooked without beef were lower than those of variation 3 cooked with beef. Variations 2, 4, and 6 were all thickened with cocoyam paste; however, the protein contents varied. The protein contents of variations 4 (4.2%) and 6 (4.3%) cooked with beef were more than that of variation 1 (1.8) cooked without meat. A similar pattern of variation was observed for these three variations in energy and all the other nutrients. Variation 2 also had more moisture (89%) compared to variations 4 (82%) and 6 (80%). Of all the “ora” soups thickened with “ukpo” (*Mucuna urens*) (variations 1, 3, and 5), variation 5, with additional protein source and less moisture content, had a higher concentration of all nutrients. Soups thickened with “ukpo” (*Mucuna urens*) had better mineral and vitamin contents compared to those thickened with cocoyam paste. The variations were wider among macroelements. The variation in protein content appeared to be related to the protein sources rather than the thickeners in this case.

The nutrient composition of the four varieties of vegetable soups differed widely (see Table 8). CV% ranged from 17% for moisture to 57% for carbohydrate. Again, vegetable soups with lower moisture (58–60%) content (variations 1 and 2) had higher nutrient content than variations 3 and 4 with higher moisture (>80%) content.

4. Discussion

The high frequency of cassava-based dishes in this study is not surprising. A similar report of the frequency of consumption of cassava among children (92%) and women (95%) in Akwa Ibom State in the South-South zone of Nigeria was given by De Moura et al. [14]. According to FAO and IFAD [15], cassava food products are the most important staples for rural and urban households in Southern Nigeria. This is because cassava as a food crop fits well into the farming system of the small-holder farmers in Southern Nigeria and is available all the year round, thus providing household food security. Compared to grains, cassava is more tolerant to low soil fertility and more resistant to drought, pest, and diseases [16]. It is also worthy of note that rice-based dishes were as popular as yam-based dishes. Although yam is one of the most prized and cherished root crops in South-eastern Nigeria, it appears

TABLE 8: Energy and nutrients composition of variations of vegetable soup.

Recipe name	Energy KJ (Kcal)	Moisture (g)	Protein (g)	CHO (g)	Fat (g)	Ash (g)	Dietary fibre (g)	Fe (mg)	Zn (mg)	Cu (mg)	Ca (mg)	P (mg)	K (mg)	Na (mg)	Mg (mg)	Vit. B1 (mg)	Vit. B2 (mg)	Vit. B3 (mg)
Vegetable soup (1)	663 (159)	58.8	3.99	30.7	2.22	2.18	2.13	2.38	0.20	0.16	171.42	276.27	201.59	139.36	183.21	0.08	0.57	0.13
Vegetable soup (2)	645 (154)	60.4	7.41	25.7	2.40	2.24	2.29	2.48	0.24	0.18	194.21	245.33	231.96	163.88	207.08	0.10	0.75	0.14
Vegetable soup (3)	227 (54)	85.8	2.81	8.8	0.88	0.89	0.82	0.94	0.09	0.06	79.57	102.73	88.01	63.08	78.07	0.05	0.28	0.05
Vegetable soup (4)	316 (75)	82.6	2.86	10.5	2.45	0.84	0.79	0.96	0.13	0.04	107.07	75.90	100.53	69.32	90.69	0.04	0.33	0.06
CV%	39.90	17.20	43.91	57.41	32.50	43.79	48.44	43.87	36.26	53.48	33.67	48.67	40.09	40.07	40.21	37.81	39.58	42.23

(1) vegetable soup with pumpkin leaves and stock fish bone; (2) vegetable soup with pumpkin leaves, stock fish head, dry fish, and meat/ice fish/smoked fish; (3) vegetable soup with pumpkin leaves and okra with crayfish and meat/fish; (4) vegetable soup with spinach and garden egg leaves with melon seed, crayfish, and ice fish. CV%: coefficient of variation.

TABLE 9

Food/ingredient	Common name/description	Botanical name
Cassava “fufu”	Fermented and boiled cassava pounded into a stiff paste	<i>Manihot esculentus</i>
Garri	Fermented and roasted cassava formed into a stiff paste by reconstituting with hot water	<i>Manihot esculentus</i>
“Abacha”	Tapioca salad/boiled, grated, and dried cassava chips softened by soaking in cold water and mixed with other traditional salad ingredients	<i>Manihot esculentus</i>
Yam	—	<i>Dioscorea</i> spp.
Rice	—	<i>Oryza sativa</i>
Wheat	—	<i>Triticum</i> spp.
Cowpea	Beans	<i>Vigna unguiculata</i>
Breadfruit	—	<i>Treculia africana</i>
Plantain	—	—
Corn	—	<i>Zea mays</i>
Semovita	A type of durum wheat flour product made into a stiff paste by stirring in hot water under low heat	<i>Triticum durum</i>
“Ukazi” leaves	Wild spinach	<i>Gnetum africanum</i>
Garden egg leaves	—	<i>Solanum melongena</i>
Prawn	—	<i>Penaeus monodon</i>
Onion	—	<i>Allium cepa</i>
Fermented oil bean seed	—	<i>Pentaclethra macrophylla</i>
Pepper	—	<i>Capsicum</i> spp.
Edible potash	Trona/an alkaline salt known as sodium sesquicarbonate	—
Nutmeg	—	<i>Monodora myristica</i>
Melon seed	—	<i>Citrullus vulgaris</i>
“Ogbono”	Dika nut	<i>Irvingia gabonensis</i>
“Ukpo”	Soup thickener made from the seeds of a leguminous plant	<i>Mucuna urens</i>
Bitter leaves	—	<i>Vernonia amygdalina</i>
Pumpkin leaves	—	<i>Telfairia occidentalis</i>
Smoked fish	Mackerel	<i>Scomber scombrus</i>
Beef	—	<i>Bos taurus</i>
Stock fish	Cod	<i>Gadus morhua</i>
Ice fish	Mackerel	<i>Scomber scombrus</i>
Palm oil	—	<i>Elaeis guineensis</i>
“Okpei”	Fermented mesquite bean	<i>Prosopis africana</i>
“Ogiri”	Fermented castor oil seed	<i>Ricinus communis</i>
Ora leaves	—	<i>Pterocarpus soyauxii</i>
Cocoyam paste	Taro	<i>Xanthosoma</i> spp.
Dry fish	Cat fish	<i>Cambarus bartonii</i>
Spinach	—	<i>Amaranthus</i> spp.
Okra	—	<i>Hibiscus esculentus</i>

that its consumption is dwindling. The popularity of rice according to Deslisle [17] has been attributed to urbanization and ease of preparation.

Bitter cassava, which is predominantly the variety cultivated and consumed in South-eastern Nigeria, is rarely eaten alone. When used as snack food (e.g., soaked garri or tapioca salad, “abacha”), it is eaten with coconut, fish, milk, groundnuts, or pork meat. Tapioca (“abacha”) salad is sometimes eaten as a snack or a full meal. As observed from this study, the most popular cassava-based dishes are those

eaten with a variety of soups (e.g., garri or “fufu”). Although cassava by itself is known to have a low protein/energy ratio, its contribution to nutrient intake cannot be viewed in isolation. Soups and other ingredients are the major nutrient contributors to cassava-based dishes; thus, their contribution will depend on the type of soup and other food materials accompanying the cassava products.

Nigerian soups vary in complexity. They are made with multiple ingredients of varying proportion and types as well as varied methods of preparation. The observed variations

in the commonly consumed soups in this study confirm the observation made by Ene-Obong et al. [6], where sources of variation were observed to be in the use, type, and quantity of animal protein and use of vegetables and thickeners. Others included seasonings and ingredient number as well as quantity.

The observed high variability in the nutrient composition of these soups suggests the need to include these different variations in a country-specific food composition table in order to avoid overestimation or underestimation of energy and nutrient intakes. According to Williamson [18], variation in nutrient composition limits the usefulness of FCDBs for both scientific and regulatory purposes. Thus, documenting and including the same dishes cooked with varying proportions and types of ingredients will help to reduce the errors in the estimation of nutrient intakes of population groups.

Based on the data presented, it was observed that moisture content, protein source, and quantity/type of ingredients and thickeners used appeared to cause the greatest variations in the energy and nutrient contents of the dishes. Generally, soups with less moisture had higher energy and nutrient contents compared to those with higher moisture content. This result is expected, since the nutrient composition of a food is inversely related to its water content. This shows that the common practice in poor households of adding water to soups and stews “so that it will be enough” according to a focus group discussion dilutes the nutrient concentration of the soup or stew and so should be discouraged. Cassava is a very poor source of most micronutrients of public health importance [19]. Overdilution of the accompanying soup could, therefore, have serious implication on the nutrient intake of household member in South-east Nigeria, particularly the vulnerable groups. Sanghvi and Murray [20] observed that infants and young children are frequently fed with these meals. According to Okeke et al. [21], such foods are not suitable for feeding young children with small stomach capacity. Another implication of this finding is that there will always be need to correct for the moisture content of these soups even when the ingredients used in preparation are similar in order to avoid overestimation of intakes.

The use of animal protein source in Nigerian soup preparation deserves special mention as a result of varying practices. Some prepare soups with little or no animal protein, while others prepare soups with an assortment of animal proteins. Apart from some religious groups like the Seventh Day Adventist, most households in South-eastern Nigeria use ground crayfish in cooking. This is a major animal protein source in the South-eastern cuisine. The ways in which the proteins are served also differ, since members of the household do not always have equal portions to consume during meals. This makes it extremely difficult to estimate what a standard portion is for any age group. Therefore, only the liquid part of the soups was analysed, while the big lumps of meat/fish were excluded. This was done to take care of individuals who may consume a cassava-based meal without any visible serving of meat/fish. The implication of this (analysing only the liquid part of the soups) is that the nutrient content of whatever quantity of meat/fish consumed by an individual will have to be calculated separately and

added to whatever the soups contribute. Despite the fact that meat/fish was not included in the analyses, it was observed, however, that the number of animal protein sources present in a recipe still determined the nutrient composition of the prepared dish. Soups cooked with smoked fish had less protein than other variations prepared with beef, dry fish, and/or stock fish. The meat/stock fish/nitrogenous extractives as well as small pieces of fishes that mixed up with the soup at the preparation stage could be responsible for the higher protein values in soups prepared with more animal protein sources. Soups prepared with meat, dry fish, and stock fish also had higher mineral values, particularly calcium, iron, potassium, magnesium, and phosphorus, since they are excellent sources of these nutrients. The implication of this finding is that women and children in some traditional societies who are denied meat and fish because of food taboos [22] are not completely left out so long as the meat or fish was among the ingredient used in preparing the meal even though the quantity may still not be adequate.

The similarity in the protein and fat content of melon (“egusi”) soup thickened with “ukpo” (*Mucuna urens*) and the one cooked with melon seed alone could be attributed to the fact that both “ukpo” (*Mucuna urens*) and melon are from the same food group (oil seeds and nuts) and the fact that both variations of melon soup were cooked with substantial amounts of animal proteins. However, the mineral profile of melon soup thickened with “ukpo” (*Mucuna urens*) was higher. “Ogbono” (*Irvingia gabonensis*) also shares the same food group with “ukpo” (*Mucuna urens*) and melon seed. However, the protein content of the soups thickened with “ogbono” (*Irvingia gabonensis*) was lower. None of them contained meat.

There was not much difference in the energy content between soup thickened with “ukpo” (*Mucuna urens*) and those thickened with “ogbono” (*Irvingia gabonensis*). Soups thickened with “ukpo” (*Mucuna urens*) in most cases contained less carbohydrate than those thickened with cocoyam paste. Cocoyam as a tuber contains more carbohydrate than seeds and nuts. Furthermore, large quantity of cocoyam was used per pot of soup. “Ukpo” (*Mucuna urens*), because of its high dietary fibre content [23], has a greater water absorbing capacity and is more viscous than cocoyam paste. It is, therefore, added in smaller quantities. The cocoyam thickened soups were, therefore, more energy-dense than the variations thickened with “ukpo” (*Mucuna urens*). Type of soup thickener should, therefore, be an important consideration when planning low-/high-energy diet.

A slight change in the ingredient composition of a recipe automatically reflects in its nutrient composition as seen in nutrient values of different recipe variations. The quantity of ingredient used reflected in the nutrient content of different variation of a particular recipe. This explained why the nutrient content of “abacha” prepared with more cowpea had more protein than the variation with less or without cowpea. “Abacha” prepared with more cowpea contributes 27.5 and 30% of the protein required daily by adult males and females, respectively, while another variation of the same dish (“abacha” and vegetable) contributes only 4.5 and 4.9% of the protein required by the same population

groups. This is understandable, since legumes (cowpea) are better protein sources than fresh vegetables and tubers. Increasing the number of ingredients in a recipe should, therefore, be encouraged over the use of basic ones. This will also encourage dietary diversity in cassava-consuming communities, since it has been shown that increased reliance on cassava leads to less dietary diversity, an association that identifies cassava consumers as a vulnerable population that may require interventions to improve nutrition [16].

5. Conclusion

Cassava dishes in form of “abacha” (tapioca salad) and “fufu”/“garri” with soups were the most commonly consumed in South-eastern Nigeria and their recipes showed great variability. Factors causing the variability included the moisture content of the dish and the type and number of ingredients and the thickening agents used. These variations in commonly consumed dishes cannot be neglected. They should be reflected in the country-specific food composition database so that nutrient intake assessment or provision of dietary guidance using such food composition database as a reference material could be more effective.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

- [1] S. F. Schakel, M. Buzzard, and S. E. Gebhardt, “Procedures for estimating the nutrient values for food composition database,” *Journal of Food Composition & Analysis*, vol. 10, pp. 102–114, 1997.
- [2] B. Burlingame, “Evidence for diet and chronic diseases relationships requires food composition data,” *Journal of Food Composition & Analysis*, vol. 16, article 109, 2003.
- [3] J. A. T. Pennington, *Variability of minerals in foods*, <https://www.nutrientdataconf.org/PastConf/NDBC21/p6-2.pdf>.
- [4] E. B. Oguntona, “Standardization of recipes in Nigeria,” in *Proceedings of the 2nd National Workshop on Standardization*, University of Ibadan, Ibadan, Nigeria, 1995.
- [5] E. C. Okeke and C. Eze, “Nutrient composition and nutritive cost of Igbo traditional vendor foods and recipes commonly eaten in Nsukka,” *Journal of Agriculture Food Environment and Extension*, vol. 5, no. 1, pp. 36–44, 2006.
- [6] H. N. Ene-Obong, R. A. Sanusi, E. A. Udentia et al., “Data collection and assessment of commonly consumed foods and recipes in six geo-political zones in Nigeria: important for the development of national food composition database and dietary assessment,” *Food Chemistry*, vol. 140, no. 3, pp. 539–549, 2013.
- [7] J. Holden, “Sources of variation in nutrient composition data,” <http://www.nutrientdataconf.org/PastConf/NDBC08/2-4-Holden.pdf>.
- [8] E. Vasilopoulou, K. Georga, E. Grill et al., “Compatibility of computed and chemically determined macronutrients and energy content of traditional Greek recipes,” *Journal of Food Composition and Analysis*, vol. 16, pp. 707–719, 2003.
- [9] J. A. T. Pennington and R. H. Albert, “Nutrient variability,” <http://www.nutrientdataconf.org/PastConf/NDBC18/11-2-Pennington.pdf>.
- [10] Worldmark encyclopedia of cultures and daily life, 2009, http://assets.cengage.com/pdf/fs_GML32509-WECD.pdf.
- [11] National Food Service Management Institute, “Measuring success with Standardized Recipes,” 2010, <http://www.nfsmi.org/resourcesoverview.aspx?ID=88>.
- [12] AOAC, *Official Methods of Analysis*, Association of Official Analytical Chemistry, Washington, DC, USA, 2005.
- [13] L. Prosky, I. Furda, J. W. Devries, T. F. Schweizer, and B. F. Harland, “Determination of total dietary fibre in foods and food products: collaborative study,” *Association of Official Analytical Chemists*, vol. 68, no. 4, pp. 677–679, 1985.
- [14] F. F. De Moura, M. Moursi, A. Lubowa et al., “Cassava intake and vitamin A status among women and preschool children in Akwa-Ibom, Nigeria,” *PLoS ONE*, vol. 10, no. 6, Article ID e0129436, 2015.
- [15] FAO and IFAD, *A Review of Cassava in Africa with Country Case Studies on Nigeria, Ghana, The United Republic Tanzania, Uganda and Benin*, IFAD International Fund for Agricultural Development, 2005.
- [16] K. Stephenson, R. Amthor, S. Mallowa et al., “Consuming cassava as a staple food places children 2–5 years old at risk for inadequate protein intake, an observational study in Kenya and Nigeria,” *Nutrition Journal*, vol. 9, article 9, 2010.
- [17] H. Deslisle, *Pattern of Urban Food Consumption in Developing Countries: Perspective from the 1980’S*, Department de Nutrition, Universite de Montreal in Consultation with the Food Policy and Nutrition Division, Food and Agriculture Organization of the United Nations, Rome, Italy, 1990, ftp://193.43.36.92/esn/nutrition/urban/delisle_paper.pdf.
- [18] C. Williamson, “The different uses of food composition databases,” Synthesis report 2, European Food Information Resource Network (EuroFIR), 2005.
- [19] A. Gegios, R. Amthor, B. Maziya-Dixon et al., “Children consuming cassava as a staple food are at risk of inadequate zinc, iron, and vitamin A intake,” *Plant Food in Humuman Nutrition*, vol. 65, pp. 64–70, 2010.
- [20] WHO, *Infant and Young Child Feeding: Model Chapter for Textbooks for Medical Students and Allied Health Professionals*, 2009, http://www.wpro.who.int/nutrition_wpr/publications/infant-childfeeding.pdf?ua=1.
- [21] E. C. Okeke, H. N. Ene-Obong, A. O. Uzuegbunam, A. O. Ozioko, S. I. Umeh, and H. Kuhnlein, “Nutrient composition of traditional foods and their contribution to energy and nutrient intakes of children and women in rural households in Igbo culture Area,” *Pakistan Journal of Nutrition*, vol. 8, no. 4, pp. 304–312, 2009.
- [22] C. Gadegbeku, R. Wayo, G. Ackah-Badu, E. Nukpe, and A. Okai, “Food taboos among residents at Ashongman-Accra, Ghana,” *Food Science and Quality Management*, vol. 15, 2013.
- [23] H. N. Ene-Obong and E. Carnovale, “Nigerian soup condiments: traditional processing and potentials as dietary fibre sources,” *Food Chemistry*, vol. 43, pp. 29–34, 1992.