



Effect of process variables on the proximate composition of instant egusi (*Citrullus vulgaris*) soup balls

Onyejiaka P I¹, Omeire G C², Peter-Ikechukwu A I², Nwokeke B C^{1*}

¹Department Food Science and Technology, Imo State Polytechnic Omuma, Oru East, Nigeria

²Department of Food Science and Technology, Federal University of Technology Owerri, Imo State, Nigeria

Abstract

Proximate compositions of instant Egusi (*Citrullus vulgaris*) Soup Balls from blends of defatted melon and usu (*Pleurotus tuber*) meal was analyzed using a three factor, three levels, Response Surface Methodology Box Behnken Design (RSM). The factors and levels adopted were the feed composition X_1 (90:10, 80:20, 70:30), Cooking time X_2 (60,90,120)min and Ball sizes X_3 of (5,10,15)g. Results showed that the moisture content of the melon soup ball samples ranged from 5.75% to 8.05% while Protein content ranged from 33.02% to 37.5%. The increase in protein content could be due to the original high protein content in melon and usu. Feed composition and cooking time affected the fat composition due to effect of heat. Fat content ranged from 7.67% to 10.23%. Increase in feed composition also increased the crude fiber (2.95 – 6.63%) but have a decreased effect on ash content (4.01 – 5.64%).

Keywords: Proximate compositions, process variables, *Citrullus vulgaris*, soup balls, response surface methodology

Introduction

Meat analogues also called a meat substitute, mock meat, faux meat or imitation meat are primarily vegetable based food products that contain proteins made from legumes (mainly soy), cereal protein or fungi which approximates certain aesthetic qualities and chemical characteristics of certain types of meat [4]. Meat analogue are primarily vegetable based food product that contain proteins made from pulses (mainly soy), cereal protein, or fungi [2]. Many meat analogues qualify as a complete protein and also contain substantial level of dietary fiber, natural antioxidants and phytochemicals, while possessing low saturated fatty acid content and no cholesterol [11]. Traditionally, soy protein was used as a popular ingredient in the production of meat analogue e.g tempeh and tofu [4]. These products have been consumed for centuries as the traditional dishes in Asian countries [3]. Recently several strategies have been developed to help consumers reduce their meat consumption. One of the strategies is based on the development of structured products. Here, vegetable protein-based food is texturized (using extrusion cooking to produce fiber-like structure) to imitate meat in chewiness and flavor. Another strategy is that meat in a meal can be replaced by the consumption of vegetables, beans, pulses, and /or nuts [12]. Melon soup ball ‘akpurukpuegusi’ is a non-fermented, traditionally processed food product obtained from melon seeds (*Citrullus vulgaris*), and *pleurotus tuber* (“Usu”) and it is consumed as a meat substitute mainly in the rural areas of South Eastern Nigeria [10]. The fiber like structure of meat analogue or meat substitute depends on the material of its components, extrusion conditions and moisture content [7]. Addition of Mushroom “Usu” *pleurotus tuber* increases texture, fibrous characteristics, physical properties and functional properties of food [10]. *Pleurotus tuber*

(Mushrooms) are considered to be a good source of proteins, low in lipid content, possess “umami” flavor which is due to the sulphur- containing amino acids and it imparts meaty taste for the products. Melon is a fat-and protein-rich leguminous seeds which after being dried and ground are used as a major substrate in production of soup ball ‘akpurukpuegusi’ [9]. Standardization of food helps in maximizing compatibility, safety, repeatability and it ensures that best possible food items are produced every time. Careful cooking and storage will help retain the nutrients in the food [14]. Response surface methodology (RSM) is a powerful mathematical and statistical technique for testing multiple process variables and their interactive and quadratic effects. It is useful in solving multivariable equations obtained from experiments simultaneously [13]. It is significant technique to determine interaction between responses (dependent variable) and factors (independent variables) and also to reduce number of experimental trials as compared to complete randomized design. It has been used for the simultaneous analysis of the effects of process parameters in fresh meat processing and also in meat product [5]. In the present study, feed compositions (70:30, 80:20, 90:10), Ball sizes (5, 10, 15g) and cooking time (60, 90,120) min. are the independent variables, while responses are dependent variables. These independent variables were optimized using central Box Behnken Design of response surface methodology. The objective of this research work was to evaluate the effect of process variables on the proximate composition of instant egusi soup balls.

Materials and Methods

Materials

The melon seeds, *Pleurotus tuber* (*usu*), pepper and salt used for this work were purchased from Relief market in Owerri, Imo state, Nigeria. All reagents used for the study are of analytical grade.

Sample Preparation

The egusi seeds were defatted using hydraulic oil press. Four hundred grams (400g) of the defatted egusi meal was mixed with 40g of milled *usu* in an electric dough mixer and kneaded with 5g of ground red pepper, 8g of salt and 5g of seasoning cube. Warm water (70°C) 100mls was added drop wise to facilitate molding, kneading continued until thick moldable dough was obtained. The feed compositions of egusi seeds and *usu* were (70:30, 80:20, 90:10). The dough was molded into different sizes (5, 10, 15g), cooked at different durations (60, 90, 120 minutes). The cooked soup balls were placed on trays and allowed to cool. The soup balls were then dried in an oven at 70°C for 5 hours to constant moisture content, and stored in sterilized containers at ambient temperature. A total of seventeen sample blends were generated using Response surface design.

Determination of Proximate Composition of Instant Egusi Soup Balls

Moisture, fat, crude fibre, protein, ash and carbohydrates content of the seed flours from de-hulled seeds were determined according to the methods of [1].

Moisture content determination

Two grams of each of the flour sample was weighed into dried weighed crucible. The samples were put into a moisture extraction oven at 105°C and heated for 3 h. The dried samples were put into desiccators, allowed to cool and reweighed. The process was reported until constant weights were obtained. The difference in weight was calculated as a percentage of the original sample.

$$\text{Percentage moisture (\%)} = \frac{W_2 - W_3}{W_2 - W_1} \times \frac{100}{1}$$

Where

W_1 = Initial weight of empty dish
 W_2 = Weight of dish + un-dried sample
 W_3 = Weight of dish + dried sample

Fat content determination

Two grams of each of the flour sample was loosely wrapped with a filter paper and put into the thimble which was fitted to a clean round bottom flask, which has been cleaned, dried and weighed. The flask contained 120 ml of petroleum ether. The sample was heated with a heating mantle and allowed to reflux for 5 h. The heating was then stopped and the thimbles with the spent samples kept and later weighed. The difference in weight was received as mass of fat and is expressed in percentage of the sample.

$$\text{Percentage fat (\%)} = \frac{W_2 - W_1}{W_3} \times \frac{100}{1}$$

Where

W_1 = weight of the empty extraction flask
 W_2 = weight of the flask and oil extracted
 W_3 = weight of the sample

Crude fibre determination

Two grams (2 g) of each flour sample and 1g asbestos was put into 200 ml of 1.25 % of H_2SO_4 and boiled for 30 minutes. The solution and content then poured into Buchner funnel secured with muslin cloth and secured with elastic

band. This were allowed to filter and residue were then put into 200 ml boiled NaOH and boiling continued for 30 minutes, then transferred to the Buchner funnel and filtered and washed thoroughly with hot distilled water. The precipitates were then rinsed twice with alcohol and thrice with petroleum ether. The residues obtained werescrapped into a clean weighed crucible and dried in the moisture extraction oven to a constant weight. The crucibles were removed, cooled in desiccators and re - weighed then, difference of weight (i.e. loss in ignition) is recorded as crucible fibre and expressed in percentage crude fibre

$$\text{Percentage Crude Fibre (\%)} = \frac{W_1 - W_2}{W_3} \times \frac{100}{1}$$

Where

W_1 = weight of sample before incineration
 W_2 = weight of sample after incineration
 W_3 = weight of original sample

Crude protein determination

The micro kjeldahl method described by [1] was used. Two grams of each of the flour samples was mixed with 10ml of concentrated H_2SO_4 in a heating tube. One table of selenium catalyst was added to the tube and mixture heated inside a fume cupboard. The digest was transferred into distilled water. Ten-millimeter portion of the digest mixed with equal volume of 45 % NaOH solution and poured into a kjeldahl distillation apparatus. The mixture was distilled and the distillate collected into 4 % boric acid solution containing 3 drops of methyl red indicator. A total of 50 ml distillate was collected and titrated as well. The sample was duplicated and the average value taken. The Nitrogen content was calculated and multiplied with 6.25 to obtain the crude protein content. This is given as:

$$\text{Percentage Nitrogen (\%)} = \frac{(100 \times N \times VF) T}{100 \times V_d}$$

Where

N= Normality of the titrate (0.1N)
 VF= Total volume of the digest= 100 ml
 T= Titre Value
 Va= Aliquot Volume distilled

Ash content determination

Two grams of each of the flour samples was weighed into a crucible, heated in a moisture extraction oven for 3 h at 100°C before being transferred into a muffle furnace at 550°C until it turned white and free of carbon. The sample was then removed from the furnace, cooled in a desiccator to a room temperature and reweighed immediately. The weight of the residual ash was then calculated as ash Content.

$$\text{Percentage Ash (\%)} = \frac{\text{Weight of Ash}}{\text{Weight of original sample}} \times \frac{100}{1}$$

Carbohydrate Content Determination

The Nitrogen free method described by [1] was used. The carbohydrate was calculated as weight by difference between 100 and the summation of other proximate

parameters as Nitrogen free Extract (NFE) percentage carbohydrate
 Nitrogen Free Extract (%) = 100- (m + p + F₁ + A + F₂)

Where

- m = moisture
- p = protein
- F₁ = Fat
- A = ash
- F₂= Crude fibre

Results and Discussion

Proximate Compositions of Instant Egusi Soup Balls

The moisture content of the samples ranged from 5.75% to 8.05%. The result (Table 1) showed that the moisture content reduces with cooking duration and also reduces with feed composition. The melon soup balls were low in terms of moisture content thus will exhibit longer shelf life [10]. Protein content of the samples ranged from 33.02% to 37.50%. Protein content of the samples increased as the feed composition of the egusi seed flour increased, hence consumption of the samples will help to supply adequate amount of protein to the body (Figure i). Fat content ranged from 7.67% to 10.23%. Fat content of a food improves the texture and helps in flavor retention in food samples which increases consumers demand [6]. Crude fibre content (Figure ii) ranged from 2.95% to 6.63%. Crude fibre content of a food helps in the removal of waste products from the body, thereby preventing constipation and many digestive system

health disorders. It will also help to prevent diseases such as diabetes mellitus, cardiovascular disease, obesity and colon cancer [8]. Ash content ranged from 4.01% to 5.64%. Ash content reduces with increase in cooking time through leaching in the boiling water. Carbohydrate content of the samples ranged from 35.42 % to 44.06 %. Carbohydrate content of the samples increased as the feed composition of *pleurotus* tubers (*usu*) increased.

Conclusion

The result from the findings in this work showed that the soup ball samples were of good nutritional value. The study has also proved that high quality and nutritional melon soup ball from our locally sourced raw materials could produce products which will be able to ameliorate the high rate of malnutrition in people. The soup ball will also serve as a meat substitute that has high protein content (33.02 - 37.5) %. The study also shows that the proximate and microbial quality of melon soup ball stored for 28 days is safe, and its microbial safety depended on the degree of hygiene practiced during production.

The response surface graph results showed that protein content increased with increasing feed composition, ball size generally has no significant effect and cooking time has some effect on the overall quality of the product. The variables that gave the best response as suggested by Response Surface Methodology (RSM) were found to be 10g ball size, feed composition (80-20)g and cooking temperature of 90°C.

Table 1: Proximate Composition (%) of Melon Soup balls

Samples	Moisture	Protein	Fat	Crude fibre	Ash	Carbohydrate
MSB ₁	5.98 ^d ±0.02	36.30 ^b ±0.01	9.30 ^{ab} ±0.08	4.59 ^b ±0.02	4.26 ^b ±0.02	39.40 ^e ±0.21
MSB ₂	7.01 ^b ±0.01	34.58 ^c ±0.03	8.48 ^b ±0.01	3.30 ^c ±0.01	4.98 ^b ±0.40	41.65 ^c ±0.15
MSB ₃	7.00 ^b ±0.02	34.58 ^c ±0.03	8.49 ^b ±0.05	3.31 ^c ±0.03	4.99 ^b ±0.15	41.63 ^c ±0.25
MSB ₄	8.05 ^a ±0.06	34.87 ^c ±0.05	8.01 ^{bc} ±0.02	2.95 ^d ±0.06	5.64 ^a ±0.01	40.48 ^d ±0.35
MSB ₅	7.07 ^b ±0.04	34.65 ^c ±0.05	8.68 ^b ±0.03	3.48 ^{bc} ±0.01	5.00 ^{ab} ±0.02	41.12 ^c ±0.01
MSB ₆	7.01 ^b ±0.02	34.58 ^c ±0.01	8.48 ^b ±0.01	3.31 ^c ±0.02	4.99 ^b ±0.02	41.63 ^c ±0.02
MSB ₇	6.12 ^c ±0.02	36.81 ^{±0.03}	10.23 ^a ±0.05	4.93 ^b ±0.05	4.37 ^{bc} ±0.05	37.54 ^f ±0.04
MSB ₈	5.90 ^f ±0.01	37.50 ^a ±0.04	10.23 ^a ±0.01	6.63 ^a ±0.06	4.32 ^c ±0.02	35.42 ^g ±0.01
MSB ₉	7.00 ^a ±0.02	34.58 ^c ±0.05	8.48 ^b ±0.00	3.30 ^c ±0.01	4.98 ^b ±0.01	41.66 ^c ±0.04
MSB ₁₀	5.75 ^d ±0.05	36.18 ^b ±0.04	9.92 ^{ab} ±0.04	4.53 ^b ±0.35	4.01 ^c ±0.05	39.61 ^e ±0.05
MSB ₁₁	7.88 ^b ±0.02	33.33 ^d ±0.01	7.72 ^c ±0.01	3.10 ^b ±0.25	5.31 ^a ±0.02	42.66 ^c ±0.04
MSB ₁₂	6.97 ^c ±0.02	34.50 ^c ±0.03	8.35 ^b ±0.05	3.25 ^b ±0.15	4.88 ^b ±0.01	42.05 ^c ±0.03
MSB ₁₃	7.11 ^b ±0.02	35.15 ^{bc} ±0.08	8.79 ^{bc} ±0.02	3.52 ^{bc} ±0.25	5.10 ^a ±0.05	40.33 ^d ±0.05
MSB ₁₄	7.01 ^b ±0.02	34.58 ^c ±0.01	8.48 ^b ±0.01	3.31 ^b ±0.15	4.98 ^b ±0.03	41.63 ^c ±0.05
MSB ₁₅	7.27 ^b ±0.02	33.02 ^d ±0.01	7.67 ^c ±0.05	3.01 ^b ±0.25	5.21 ^a ±0.02	43.79 ^b ±0.04
MSB ₁₆	6.91 ^c ±0.04	34.88 ^c ±0.03	8.57 ^c ±0.03	3.33 ^b ±0.25	4.95 ^b ±0.01	41.36 ^c ±0.06
MSB ₁₇	5.90 ^d ±0.03	33.70 ^d ±0.05	7.81 ^{cd} ±0.05	3.15 ^b ±0.45	5.41 ^a ±0.10	44.06 ^a ±0.20
LSD	0.0027	0.3590	0.1909	0.0105	0.0836	0.0145

Mean values having different superscripts along the same column are significantly different (p≤0.05).

Keys: (X₁)=(Melon: Usu),Ball size(X₂),Cooking

time(X₃)MSB₁(X₁)(70:30)(X₂)(5g)(X₃)(90mins),MSB₂(X₁)(90:10)(X₂)(5g)(X₃)(90mins),MSB₃(X₁)(70:30)(X₂)(15g)(X₃)(90mins),MSB₄(X₁)(90:10)(X₂)(15g)(X₃)(90mins)MSB₅(X₁)(70:30)(X₂)(10g)(X₃)(60mins)MSB₆(X₁)(90:10)(X₂)(10g)(X₃)(60mins),MSB₇(X₁)(70:30)(X₂)(10g)(X₃)(120mins)MSB₈(X₁)(90:10)(X₂)(10g)(X₃)(120mins)MSB₉(X₁)(80:20)(X₂)(5g)(X₃)(60mins),MSB₁₀(X₁)(80:20)(X₂)(15g)(X₃)(60mins),MSB₁₁(X₁)(80:20)(X₂)(5g)(X₃)(120mins),MSB₁₂(X₁)(80:20)(X₂)(15g)(X₃)(120mins),MSB₁₃(X₁)(80:20)(X₂)(10g)(X₃)(90mins),MSB₁₄(X₁)(80:20)(X₂)(10g)(X₃)(90mins),MSB₁₅(X₁)(80:20)(X₂)(10g)(X₃)(120mins),MSB₁₆(X₁)(70:30)(5g)(X₃)(120mins)MSB₁₇(X₁)(70:30)(X₂)(5g)(X₃)(120mins)

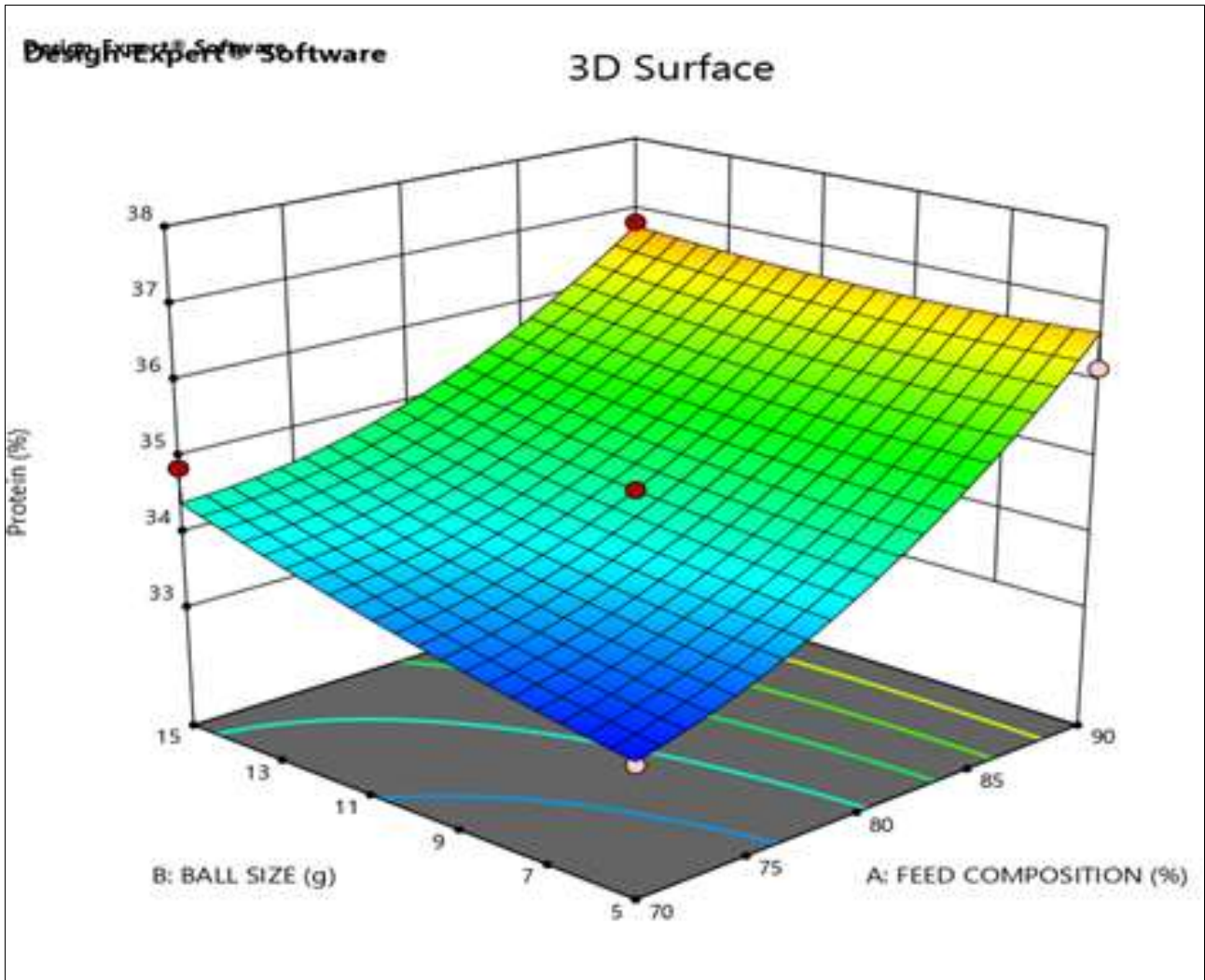


Fig 1: Effect of feed composition and Ball size on the protein content of soup Ball

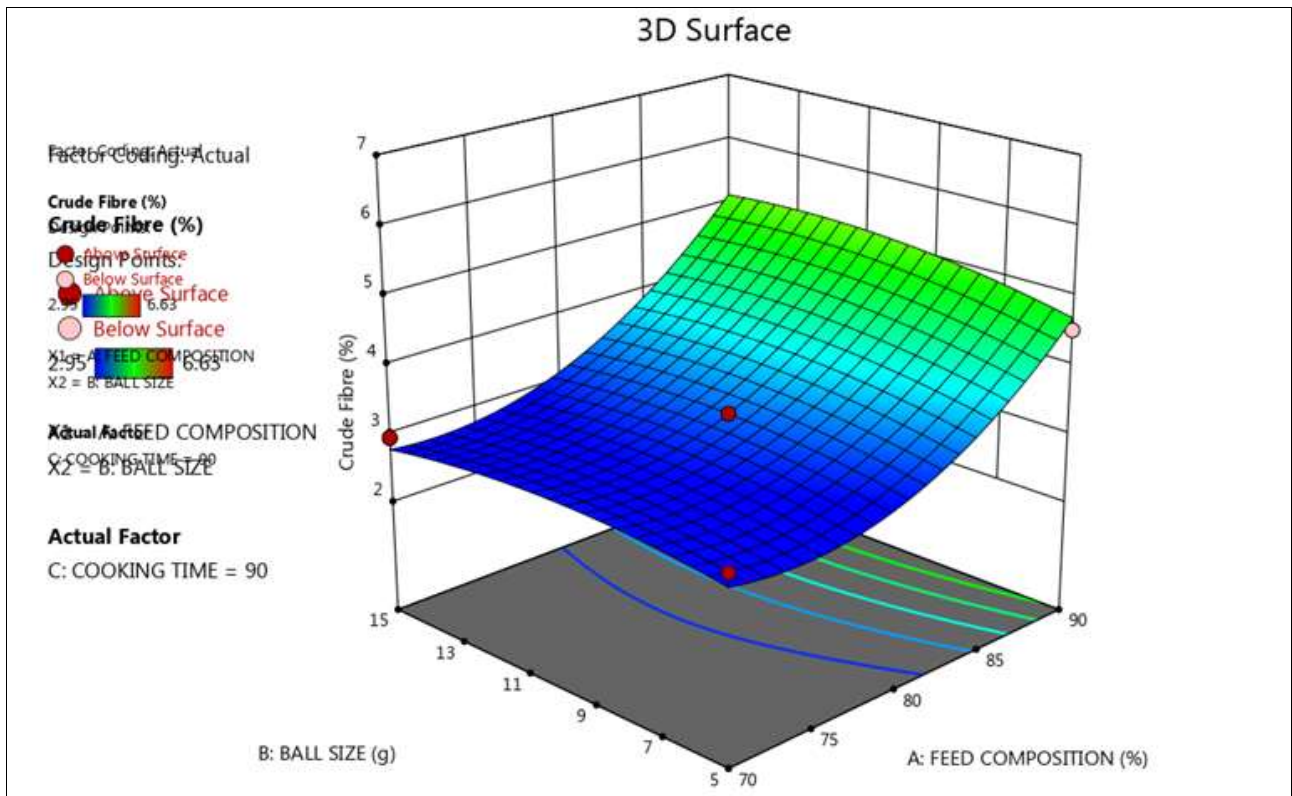


Fig 2: Effects of Feed Composition and Ball size on the Crude Fiber

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