

# Formulation of Soy Bean Texturized Vegetable Protein (TVP) As Affordable Alternative Meat/Protein Supplement Amidst Current Food Security Crisis in Nigeria

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*Abstract- Poor nutrition involving protein remains a major health challenge among young ones and adults in Nigeria. This problem emanated from inadequate supply of protein caused by high price of animal protein, which are mostly more preferred to those of plant origin. The protein of soy bean contains considerable quantity of lysine, (6.2g/16gN) with little quantity of methionine (2.9g/16gN) and Cystine (2.9g/16gN) making its protein content and amino acid composition approximate to composition of animal proteins. This study seeks to as part of measures to combat protein shortages in form of meat analogues, formulate ideal Texturized Vegetable Protein meat analogue from Soy bean seed to serve as affordable alternative for meat protein in our diet and rich source of protein to vegetarians and to establish Optimum parameters for processing Soybean TVP. Measured amount of Soy bean was soaked in water and dehulled after fours. The dehulled soybean was grinded and mixed with appropriate quantities of water and ingredients to form a paste. An Acceptable and nutritious soybean TVPN meat analogue was developed which would be compared favorably with the control sample (cooked meat) in overall acceptability. This was followed by determination of functional properties of TVP and the Sensory evaluation freshly produced Soybean TVP samples for aroma, colour, texture, taste, chewiness and acceptability by twenty panelists on a hedonic scale(9-point) where 1 represent dislike extremely and 9 extremely like (Iwe, 2002). The determination and measurements done was subjected to statistical analysis using statistical package for social sciences (SPSS version 21) and the result obtained showed that the soy bean texturized*

*vegetable protein produced was approved and generally accepted for adoption by sensory evaluation panel as a cheap and affordable alternative source of meat protein for both vegetarians and the general populace.*

## I. INTRODUCTION

Inadequate protein in our diet is regarded as the major cause of poor nutrition in the young and adults in developing nations. (Okpala et al., 2010). Poor nutrition involving protein remains a major health challenge among young ones (UNICEF, 2016). This problem emanated from inadequate supply of protein caused by high price of animal protein, which are mostly more preferred to those of plant origin. Texturization of plant protein, especially legumes as meat alternative has been identified as a reliable option in checking the scourge (Omohimi et al., 2013). Texturized Vegetable Proteins (TVP) are good alternatives to animal protein. They are carefully manipulated products of plant origin that could possibly be substituted for meat analogues. Attempt to widen the narrow protein-rich food base beyond meat to include meat-like products has made scientific investigation in to some native known plants for protein and their mechanical manipulation for use in food. Soy bean is an important cereal crop which serves as a rich source of plant protein for millions of

people in Nigeria and more than 40% of the world's population. Soy bean is one legumes with high nutritional value containing about 40% protein content which have tremendous potential for alleviating malnutrition in Nigeria. Soy bean seeds contain about 40% crude protein and about 20% of fat. The protein of soy bean contains considerable quantity of lysine, (6.2g/16gN) with little quantity of methionine (2.9g/16gN) and Cystine (2.9g/16gN) making its protein content and amino acid composition approximate to composition of animal proteins therefore it can be used as a replacement of meat protein. Soybean has also been used to fortify traditional foods such as soy vegetable soup, soya milk (Kunu zaki), soy okpa, soy alubo etc across all regions in Nigeria (Hassana.,2007). Soy bean production and utilization have been on the rise in Nigeria. This have been made possible by the successful development of improved varieties that can grow well in Nigeria by International Institute for Tropical Agriculture (IITA) Analysis of soy bean-based products showed that they contain more protein and minerals than the protein content of black-eyed beans and has high fat content which is easily digestible. Soy bean various flour (full fat, defatted, extruded, soy residue flours) have been successfully used to improve the protein contents of the traditional Nigeria food, some of which have been scales up to industrial level.

The prevailing economic recession worldwide and as well as the countinuous rise in prices of commodities, especially animal meat has made meat unaproacheable to common citizen. In this regard there is need to develop alternative ways and means of alleviating this economic decline in food sector and present study is carried out to develop an alternative of animal meat utilizing soy beans from indigenous sources. The mandate of present study was the preparation of

texturized vegetable protein using cheap indigenous source soybean as raw material and to prepare and evaluate the soybean texturized vegetable protein-based patties.

The developed soy bean TVP will offer cheap protein alternative for meat to reduce malnutrition and deficiency diseases in the general populace in the face of this present economic hardship in Nigeria and also provide vegetarians with meat-like option since they cannot eat meat. Vegetarians are individuals that rely solely on grains, vegetables, fruits and nuts as diet and avoid meat, poultry and fish in their diet.

## II. MATERIALS AND METHODS

### 2.1 Procurement and cleaning of Raw materials:

Soybean seeds were obtain from National Cereals Research Institute Baddegi, Niger State, Dangote Iodized enriched Salt obtained from Bida Modern Market, Vegetable Oil and 1000mL. capacity PET bottle. The procured soy bean seeds were manually cleaned to remove dust particles, stones, dirt and damaged seeds and other impurities after which the cleaned soybean seeds were soaked and dehulled and manually. The cleaned and dehulled soybean seeds were then grinded or milled in to flour for further processes.

### 2.2: Production of Soybean Texturized Vegetable Protein (Meat Ball) from defatted Soybean flour

Step 1: The ingredients were weighed according to the mixing formula (MF) in Table 1.

Table 1: Formulas used in mixing ingredients for Soybean TVP

Table 1: Mixing ingredients of surveyed TVP formulas

Ingredients	Mixing Formula (MF)	MF1	MF2	MF3	MF4	MF5	MF6	MF7	MF8	MF9	MF10
Soy flour		26	26	26	26	26	26	26	26	26	26
ISP		70	70	70	70	70	70	70	70	70	70
Soybean oil		4	4	4	4	4	4	4	4	4	4
Gluten (%)		0	4	8	12	16	-	-	-	-	-
PDX (%)		-	-	-	-	-	0	0.3	0.6	0.9	1.2

Ingredients	Mixing Formula (MF)										
Salt (%)	2	2	2	2	2	2	2	2	2	2	2
HVP (%)	5	5	5	5	5	5	5	5	5	5	5
Water (%)	200	200	200	200	200	200	200	200	200	200	200

Note: The main ingredient mixture was fixed according to the ratio of soybean flour: ISP: soybean oil = 26: 70: 4 (% by weight), while the remaining ingredients and water were calculated as a percentage of the total weight of the main ingredient mixture. The compositions of gluten (G) and Polydextrose (PDX) in the MFs were as follows: MF1: 0% G, 1% PDX; MF2: 4% G, 1% PDX; MF3: 8% G, 1% PDX; MF4: 12% G, 1% PDX; MF5: 16% G, 1% PDX; MF6: 16% G, 0% PDX; MF7: 16% G, 0.3% PDX; MF8: 16% G, 0.6% PDX; MF9: 16% G, 0.9% PDX and MF10: 16% G, 1.2% PDX.

Step 2: The preparation of the water mixture for blending was done by using a graduated cylinder to measure water, salt and poured it into a beaker. The mixture was though roughly stired with a glass rod till everything desolved

#### Step 3: Mixing

All the ingredients (onions, Maggi and pepper) apart from the ones already included in the water mixture and oil were added to the dough mixer (model SP-800, Spar-Taiwan) and the mixer regulated at speed level 1 for 1min and 30s to blend the dry ingredients evenly.

The water mixture was then added to the mixer and mix at speed level 2 for 1 min and 30s. This is followed by addition of vegetable oil to the mixture and adjustment of the mixer to speed level 2 for 1 min and 30 s to form a paste or dough mass.

#### Step 4: Shaping and Slicing

The dough mass was then put in to a grinder machine to form strands of dough with diameter 20mm. Then, the Texturized Vegetable Protein (TVP) meat analogue or dough strands were sliced and shaped in to pieces with a length of 10 mm.

#### Step 5: Frying and Drying

The sliced TVP cuttings were placed in an oil –fry frying pot for 60 minutes and then transferred to a

drying cabinet and dried at a temperature of 90 ocfor 45minutes

#### 2.3 Water absorption capacity (WAC) determination

Determination of WAC was done using the method described by Oni Yuliarti et al. (2021) with modifications. The weight of the samples was measured and then moistened in 100 mL of distilled water at 50 °C for 12 h. Afterward, the excess water was drained from the samples using a strainer for 15 min. The results was calculated as the average of three measurements (Yuliarti et al., 2021). The formula for calculating WAC as shown in Eq(1):

$$WAC = \frac{((Weight\ of\ sample\ after\ moistening) - WSBM)}{(Weight\ of\ Sample\ Before\ Moistening)} * 100$$

#### 2.5 Sensory evaluation

The Sensory characteristics of the freshly produced Soybean TVP samples were evaluated for aroma, colouring, texture, taste, chewiness and general acceptability by twenty (20) panelists on a hedonic scale(9-point) where 1 represent dislike extremely and 9 extremely like I,e 1 been the minimum score and 5-10 is the maximum score. The determination of the preference in color, flavor, taste, texture and overall acceptability according to the procedure described by Stone and Sidel (1998).

#### 2.4 Soybean TVP Texture Determination ×100 (%)

(1) The texture of the TVP was determined following the method described by Nguyet T. M. et al. (2023) with slight modifications. The samples were cut into lengths of 10 mm and diameters of 10 mm and soaked in water for 45 min. Then, the excess water was drained using a strainer for 15 min. The TVP samples were placed on the closed end of a water-filled tube with a diameter of 21 mm and a height of 20 mm. Subsequently, the samples were compressed using a Texture Profile Analysis (TPA) machine equipped with a cylindrical probe with a diameter of 25.4 mm

and a length of 35 mm. The testing conditions were as follows: pre-test speed = 2 mm.s<sup>-1</sup>, test speed = 2 mm.s<sup>-1</sup>, post-test speed = 2 mm.s<sup>-1</sup>, deformation = 50 %, trigger force = 0.002 N, interval time between two compressions: 3 s.

### 2.5 Determination of the TVP density

Determination of density of the sample was done using millet. The tube of a measuring cylinder, was fill with the millet, and record the weight of the millet recorded. The sample was then filled in the cylinder with the millet and note of the weight of the millet and the sample taken. The density of the sample is determined by the formula:

$$D = \frac{\text{Mass of millet}}{\text{Volume of the pycnometer}}$$

### 2.6 Sensory evaluation

The Sensory characteristics of the freshly produced Soybean TVP samples were evaluated for aroma, colouring, texture, taste, chewiness and general acceptability by twenty (20) panelists on a hedonic scale(9-point) where 1 represent dislike extremely and

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### 2.7 Statistical analysis

The results obtained after three three times repeated experiments were and presented as mean ± SD. Statgraphics Centuration XV.I (Version 15.1.2, Corporate Enterprise, USA) was used to analyze experimental data and evaluate the LSD with α = 5 %. Sensory data obtained from the panelist was analyzed statistically using simple percentage and frequencies.

## III. RESULTS AND DISCUSSION

### 3.1 Structural properties of the TVP

The structural properties (see Table 2) were crucial in determining the quality of plant-based proteins, as the main goal of meat substitutes was to mimic the desired texture of real meat. The structural properties significantly differ among the formulas (P < 0.05).

Table 1: Structural properties of the TVP samples

Samples	Hardness (N)	Cohesiveness	Springiness (mm)	Chewiness (mJ)
CS	6.60 ± 0.31 <sup>a, B</sup>	0.73 ± 0.06 <sup>a, A</sup>	4.49 ± 0.81 <sup>ab, BC</sup>	20.31 ± 3.81 <sup>a, A</sup>
Investigate suitable gluten content with a 4 % increment step and a fixed PDX content of 0.3 %				
MF1	1.70 ± 0.37 <sup>d</sup>	0.76 ± 0.22 <sup>a</sup>	4.20 ± 0.83 <sup>c</sup>	4.92 ± 0.44 <sup>b</sup>
MF2	2.43 ± 0.21 <sup>c</sup>	0.56 ± 0.05 <sup>ab</sup>	5.43 ± 0.09 <sup>ab</sup>	7.33 ± 0.70 <sup>b</sup>
MF3	4.44 ± 0.05 <sup>b</sup>	0.43 ± 0.09 <sup>b</sup>	5.53 ± 0.40 <sup>ab</sup>	17.82 ± 3.83 <sup>a</sup>
MF4	7.52 ± 0.33 <sup>a</sup>	0.40 ± 0.05 <sup>b</sup>	5.75 ± 0.78 <sup>a</sup>	18.24 ± 5.30 <sup>a</sup>
Investigate suitable PDX content with a 0.3 % increment step and a fixed gluten content of 16 %				
MF5	2.33 ± 0.11 <sup>D</sup>	0.49 ± 0.02 <sup>B</sup>	3.47 ± 1.04 <sup>C</sup>	5.15 ± 0.92 <sup>C</sup>
MF6	4.61 ± 0.08 <sup>C</sup>	0.49 ± 0.06 <sup>B</sup>	5.36 ± 0.30 <sup>AB</sup>	12.17 ± 0.96 <sup>B</sup>
MF7	6.49 ± 0.25 <sup>B</sup>	0.48 ± 0.06 <sup>B</sup>	5.93 ± 0.12 <sup>A</sup>	16.98 ± 1.21 <sup>A</sup>
MF8	6.96 ± 0.18 <sup>A</sup>	0.45 ± 0.05 <sup>B</sup>	6.34 ± 0.13 <sup>A</sup>	18.29 ± 1.78 <sup>A</sup>

Hardness was calculated from the maximum force during the first compression. The hardness of the gluten-examined samples increased from 1.70 N to 7.60 N. This difference was attributed to the variation in gluten content among the samples. Among them, MF5 had the highest hardness (6.52 N) and was the

closest to CS (6.60 N) due to its highest gluten content. Gluten played a role in creating a protein network and was the primary binding agent in the mixture to improve the structure, hardness, and chewiness of the product. The cohesiveness force value decreased from 0.73 to 0.40. This difference may be due to the

increased moisture content of the samples ranging from 3.89 % to 7.29 %. Wi et al. (2020) reported that cohesive force decreases as moisture content increases. Both springiness and chewiness tended to increase from MF1 to MF5, indicating that higher gluten content helps the product's structure to better recover its original shape after being subjected to force. The hardness of the PDX-examined samples, MF6 (2.33 N) and MF7 (2.37 N), showed similarities. MF6 did not contain PDX, while MF7 had 0.3 % PDX supplementation. It can be observed that PDX at a low concentration (0.3 %) did not significantly affect the structure of the product. Serin and Sayar (2017) reported that using PDX increases the product's hardness. The increasing concentration of PDX led to differences among the samples. MF10, with the highest PDX content (1.2 %), had a higher hardness than the control sample. MF9, with a PDX content of 0.9 %, had a structural similarity to the control sample. This study proved that both gluten and PDX had a common effect of increasing hardness, springiness, and chewiness while reducing cohesiveness.

The developed TVP meatball (illustrated as Figure 3c) achieved moisture content  $7.42 \pm 0.02$  %, specific weight  $0.43 \pm 0.03$  (kg.m<sup>-3</sup>), WAC:  $150.68 \pm 5.40$  %, hardness:  $6.51 \pm 0.37$  (N), cohesiveness:  $0.47 \pm 0.04$ , springiness:  $5.73 \pm 0.19$  (mm), chewiness:  $17.53 \pm 1.16$  (mJ). Some main nutritional components of TVP pellets were determined as follows (in % weight) protein:  $77.25 \pm 1.88$ , lipid:  $4.75 \pm 0.26$ , total ash:  $5.25 \pm 0.63$ , and fiber:  $6.54 \pm 1.97$ . As a designed formula, the final nutritional components of TVP pellets have a very high protein content, more than three times that of animal meat.

Panelist response to presentation of Soybean TVP meat analogue

Table 2: Response to the presentation of the Soybean TVP Meat Analogue

Presentation	Frequencies	Percentages
Very Attractive	12	60%
Attractive	6	30%
Fairly Attractive	2	10%

Presentation	Frequencies	Percentages
Not Attractive	0	0%
Total	20	100%

From the panelist responses on Table 1 above, 60% of the respondents Agree that the Soybean TVP Meat analogue served to them was very attractive while 30% of the respondents said the meat analogue served to them was attractive and 20% of the panelist said the meat analogue was fairly attractive and none of the said the meat analogue served to them was attractive.

Table 3: Response to the Taste and flavour of the Soybean TVP Meat Analogue

Taste	Frequencies	Percentages
Very Good	14	70%
Good	5	25%
Fairly Good	1	5%
Tasteless	0	0%
Total	20	100%

From the panelist responses on Table 2 above, The meat soybean TVP meat analogue has been reported to have distinct flavor and taste as 70% of the respondents Agree that the Soybean TVP Meat analogue served to them was very good while 25% of the respondents said the meat analogue served to them was good and 5% of the panelist said the meat analogue was fairly good and none of the said the meat analogue served to them was test less.

Table 4: Response to the Consistency/ texture of the Soybean TVP Meat Analogue

Consistency	Frequency	Percentage
Very Smooth	8	40%
Smooth	10	50%
Fairly Rough	2	10%
Rough	0	0%
Total	20	100%

From the panelist responses on Table 3 above, 40% of the respondents Agree that the Soybean TVP Meat analogue served to them was very smooth while 50% of the respondents said the meat analogue served to them was smooth and 20% of the panelist said the meat

analogue was fairly smooth and none of the said the meat analogue served to them was rough.

Table 5: Response to the Colour of the Soybean TVP Meat Analogue

Colour	Frequencies	Percentage
Excellently Bright	16	80%
Very Bright	2	10%
Bright	2	10%
Dull	0	0%
Total	20	100%

From the panelist responses on Table 5 above, 80% of the respondents Agrees that the Soybean TVP Meat analogue served to them was excellently brightly coloured while 10% of the respondents said the meat analogue served to them was very bright and 20% of the panelist said the meat analogue was bright and none of the said the meat analogue served to them was dull.

Table 6: Response to the Acceptance of the Soybean TVP Meat Analogue

Response	Frequency	Percentage
Yes	18	90%
No	2	10%
Total	20	100%

From the panelist responses on Table 3 above, 90% of the respondents Agrees that the Soybean TVP Meat analogue served to them was very acceptable while only 10% of the respondents said the meat analogue served to them was not acceptable

#### IV. CONCLUSION

From the findings of this present research, Consumption of Standard Soybean Texturized Vegetable Protein (TVP) meat analogue is a cheap and affordable alternative to meat as it contains all the essential amino acids contain in the meat for both vegetarians and general populace. It is therefore safe to conclude that its consumption is a reliable tool in checking and reducing protein Deficiency Diseases and contribute to National food Security.

#### V. RECOMMENDATIONS

- Large scale production of soybean should be encourage to serve as cheap raw materials for production of soybean TVP
- .Catering and hotel managers and supervisors should train and encourage the trainees to use soybean TVP especially for vegetarians
- More research should be explore in soybean as substitute for wheat flour in production of other baked production catering industry.

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