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Nutritional and Sensory Characterization of Meat Analogues from Soybean, Pigeon Pea and Cowpea

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ABSTRACT

The study evaluated the nutritional and sensory characterization of meat analogues from soybean, pigeon pea and cowpea. It was an experimental study that produced meat analogues using standard procedure. The meat analogue products were coded thus: soyabean (SMB100-control), cowpea (CPM101) and pigeon pea (PPM102). Proximate analysis using standard procedure to determine the moisture, crude protein, fat, ash and fibre and sensory characterization were done. Carbohydrate was determined using the arithmetic difference method. Energy value was also determined. Data were analysed using IBM SPSS version 23 and ANOVA determined the significant differences and significance judged at ($P < 0.05$).

Result showed that SBM100 had the highest protein (25.91%), fat (25.91%) and energy (338.81 k/cal) values. Sample PPM102 had a protein content of 22.06% while the fat content (3.65%) compared with CPM101 (3.99%). Significantly, CPM101 had the highest ash (2.51%) and carbohydrate content (49.79%). There were no significance differences ($P < 0.05$) in the taste and mouth-feel of the meat analogues.

Following the results, meat analogues from pigeon pea and cowpea could be an alternative to soybean meat analogue in the future for ensuring food security and combating malnutrition.

Keywords: Meat analogue, soybean, cowpea, pigeon pea, and sensory properties

Introduction

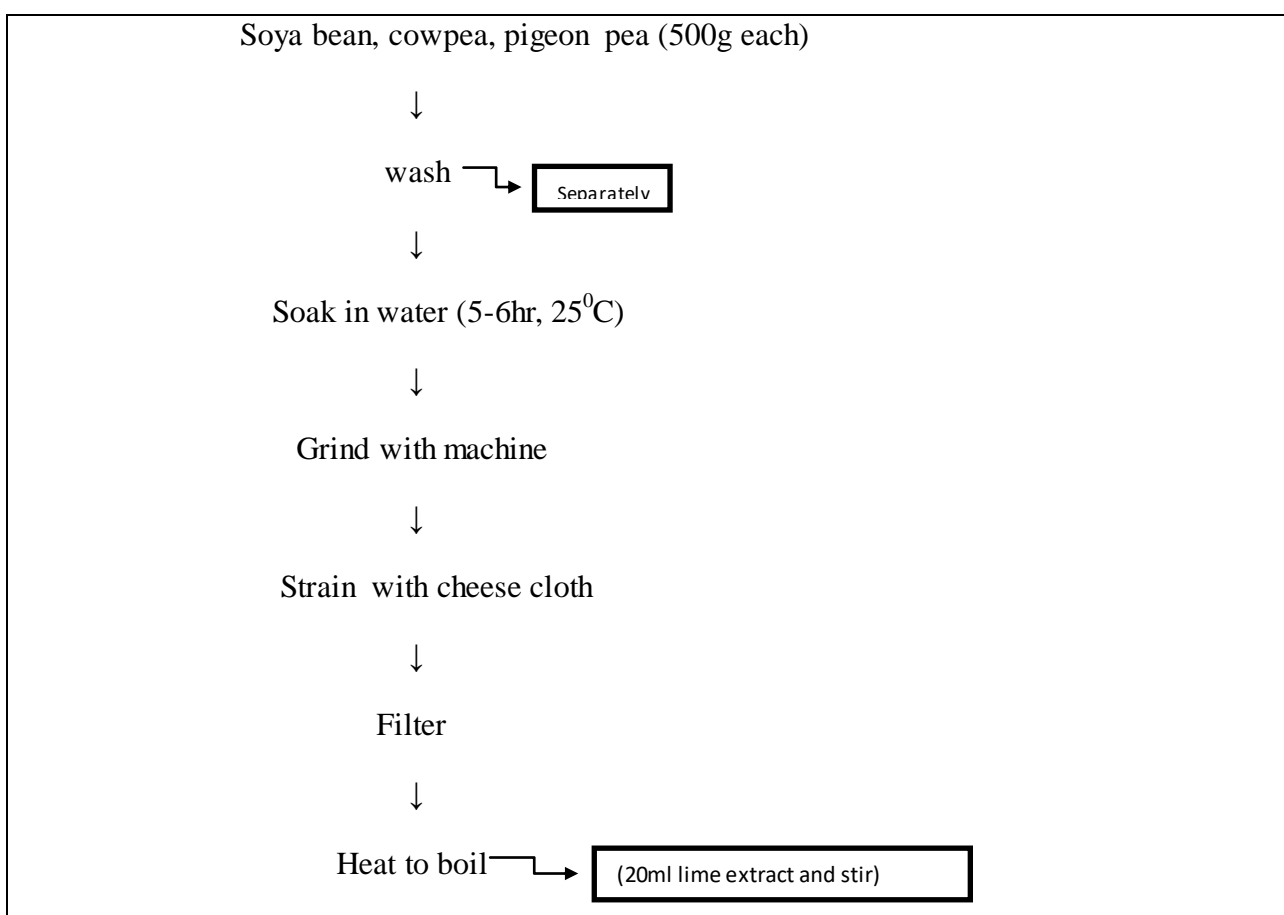
Meat analogue, also known as meat substitute, mock meat or imitation meat is a plant based meat product alternative designed to imitate animal meat appearance, taste, feel and texture (Luong et al. 2024). Soybean and peas are the most widely used plant based alternatives for meat analogues (Fu et al. 2021). Health, environmental or ethical aspects are many a reasons why consumers and food producers are looking for replacements for meat and meat products (Kołodziejczka et al. 2021). Cowpea (*Vigna unguiculata*) which have low energy density is considered as a nutrient dense food. Cowpea grain contains about 23–32% protein, 50–60% carbohydrate and 1% fat (Abebe and

Alemayehu, 2022). It is a valuable food and animal feed especially in semi-arid tropics of Africa, Asia and the Americas (IITA, 2024). Pigeon pea (*Cajanus cajan* (L) Millsp) according to Gerrano et al. (2022) is one of the six important legumes produced in the world. In their discovery, Ye and Fan, (2021) found out it is largely considered as an orphan crop, which has been cultivated by humans but not fully used so far. It has great potential to tackle the food security and nutritional health all over the world.

Dietary consumption of pigeon pea is very limited across the world and its application in food industry is also rare (Singh and Kumar, 2022). There has not been any report or study that showed the possibility of producing meat analogues from pigeon pea and cowpea. The meat analogues ever produced has been mostly from soybeans and peas. This raised the enthusiasm of this study to produce meat analogues from these underutilized legumes, pigeon pea and cowpea which are very common and indigenous to Nigerian South East locality by developing and producing cheap, innovative, value-added products from legumes which can aid food security.

Materials and method:

Procurement and preparation of samples: The cowpea, pigeon pea and soybean seeds used for this study were procured from Orie-ugba market in Abia State. It was an experimental study that produced meat analogues using standard procedure. The meat analogues produced were coded thus: SMB100 for soybean (control), CPM101 for cowpea and PPM102 for pigeon pea meat analogues respectively. The procedure for preparation and production of the meat analogues are shown in a flow chart.



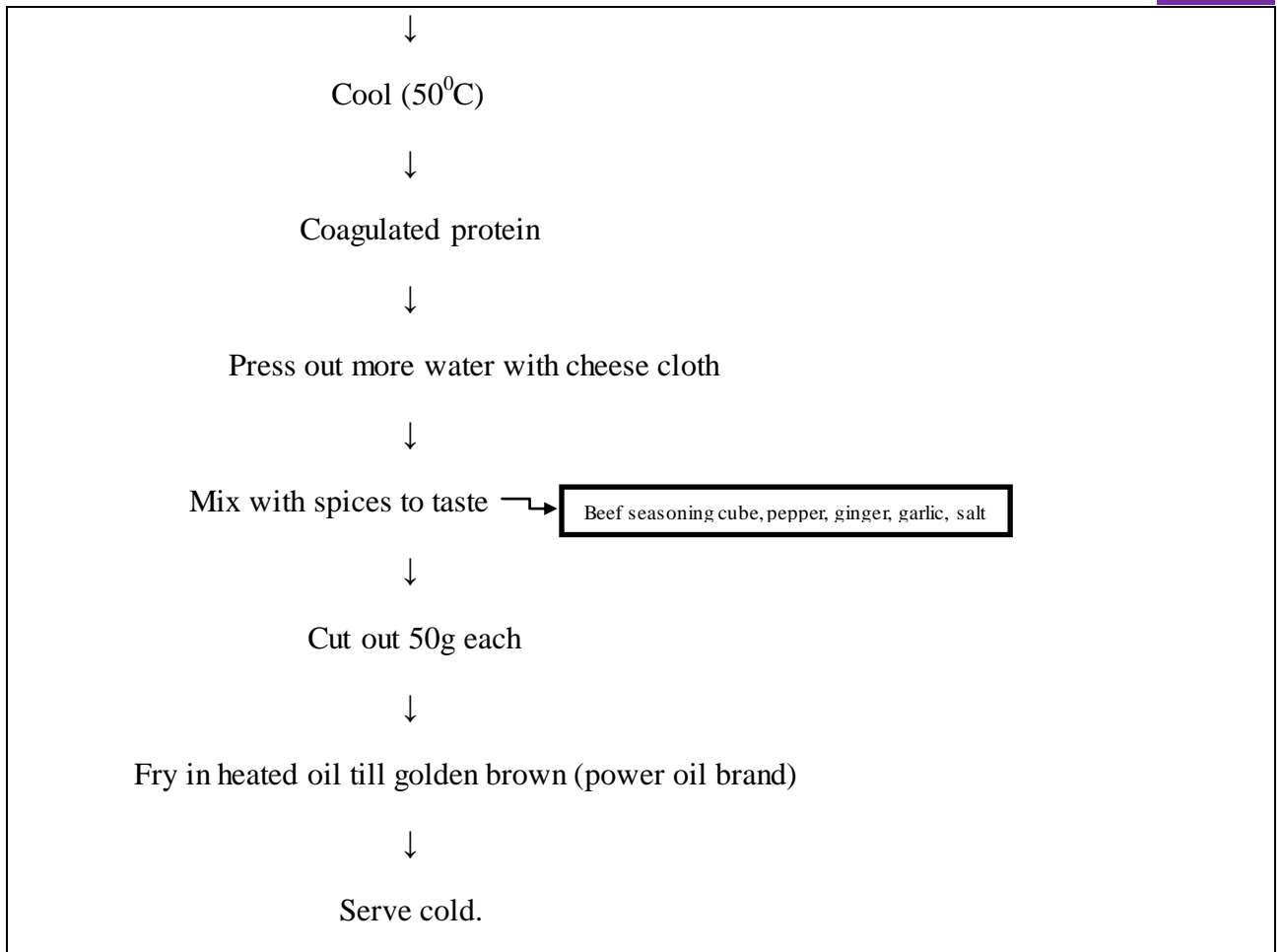


Fig.1. Flow chart showing the production technology of the meat analogue using, soya bean, cowpea and pigeon pea (adopted from Bakshi et al. 2013 and modified)

Proximate analysis:

The standard method of AOAC (2023) was used for the determination of proximate content of the samples. The hot air oven method was used in determination of moisture. Crude protein was determined using the Kjeldahl method of protein analysis. Soxhlet method was used for crude fat extraction. Ash was determined by heating 5g of the sample in a tarred porcelain crucible inside a muffle furnace set at 500°C for 6hours. Crude fibre was also determined. The energy value was calculated in Kcal/100g, using the Atwater method.

Carbohydrate

Carbohydrate was calculated and expressed as the Nitrogen free extract (NFE) as follows:

$$\text{NFE (\%)} = 100 - (\text{A} + \text{B} + \text{C} + \text{D} + \text{E})$$

A = moisture value (%), B = crude protein value (%), C = crude lipid value (%)
D = crude fibre value (%), E = ash value (%)

Sensory assessment:

Mihafu et.al (2020) sensory evaluation method was used to assess the sensory attributes of the meat analogue samples. The appearance, flavour, taste, mouth-feel and general acceptability of meat analogues were evaluated by a 20-panel evaluators from Human Nutrition and Dietetics, Michael Okpara University of Agriculture, Umudike, Abia State. A sensory evaluation form was given to the panelist after consenting to participate in the evaluation process. Sensory was scored using a 9-point hedonic scale form.

Result obtained from triplicate determinations of proximate composition and sensory evaluation were statistically analysed using SPSS version 20 and significance judged at ($P < 0.05$).

Result discussion:

Proximate composition result is shown in table.1.

Meat analogue sample PPM102 had a higher moisture content (25.76%) when compared with (23.69%) of CPM101 and SBM100 (20.46%). Meanwhile, moisture contents were lower than 50.92% reported by Dedin et al. (2021). High moisture content of food is an indication that they would be susceptible to spoilage if not preserved properly.

The protein content of the meat analogue samples showed significant differences ($P < 0.05$) and ranged from (19.20% - 25.91%). Product SBM100 had the highest (25.91%) protein content while CPM101 is 19.20%. Meanwhile, PPM102 (22.06%) compared well with the control sample. The protein content obtained from this study is in line with 21.68% published in Uju et al. (2019) study of meat analogues from different protein sources. Therefore, the protein content of samples CPM101 and PPM102 shows that they could be used for meat analogue production in the future.

The meat analogues fat content ranged from (3.65% - 5.68%). Sample SBM100 had higher fat content (25.91%) when compared with CPM101 (3.99%) and PPM102 (3.65%). Meanwhile, PPM102 had the least fat value among the samples. The high fat content obtained in SBM100 could be due to the fact that soybean is known to contain appreciable amount of oil. This also signified that this meat analogue product may undergo rapid oxidative rancidity during storage if not suitably preserved. The result obtained is in line with 5.68% to 6.63% reported by Uju et al. (2019) in the study of meat analogues from different protein sources.

The fibre content of the meat analogues showed significant differences ($P < 0.05$) and ranged from (0.38% - 1.81%). Meat analogue sample PPM102 had a significant ($P < 0.05$) higher crude fibre content (1.81%) than CPM101 (0.81%) and SBM100 (0.38%). High crude fiber content in foods is an indication of disease (colon cancer, cardiovascular diseases) management potential.

The ash content of the meat analogues also showed significant differences ($P < 0.05$) and ranged from (1.55% - 2.51%). Sample CPM101 significantly ($P < 0.05$) had a higher ash content (2.51%) when compared with PPM102 (2.09%) and SBM100 (1.55%). Meanwhile, the values of the ash content of the meat analogues were lower than 3.21- 4.07% of meat analogues produced from dry-fractionated pea and oat proteins reported by David et al. (2020).

The carbohydrate content of the meat analogue samples ranged from (44.63% - 49.79%). Sample CPM101 had the highest carbohydrate content (49.79%), followed by SBM100 (46.01%) and

PPM102 (44.63%). The high carbohydrate content of sample CPM101 could be linked to its low protein content.

The energy value of the meat analogues showed significant differences ($P < 0.05$) and ranged from (299.62 - 338.81k/cal). Sample SBM100 had the highest energy value (338.81k/cal) while PPM102 had the lowest energy value (299.62k/cal). The high energy value observed in sample SBM100 could be associated to the high fat value content. The result therefore, revealed that the meat analogues would contribute to 11.6 to 10.0% of RDA energy value.

The sensory attributes of the meat analogue samples are presented in table 2. Result shows that all the meat analogue samples did not vary significantly ($P > 0.05$) in terms of mouthfeel and taste. Meanwhile, sample SBM100 had the highest score in appearance, aroma and texture while PPM102 and CPM100 showed no significant difference ($P > 0.05$) in these parameters.

The general acceptability of the meat analogue showed that SBM100 and CPM101 with mean values of 6.70 and 6.40 were more generally accepted than sample PPM102 (5.40) according to the rating in the likert scale. The low acceptance of PPM102 could be associated to the low sensory scores in the parameters tested. This is not surprising because pigeon pea is an underutilized and an uncommonly consumed legume in the area of the study.

Conclusion: From the results obtained in this research study, it has shown that meat analogues from pigeon pea and cowpea could be an alternative to soya bean meat analogue in the nearest future, for food security and combating protein energy malnutrition. Meanwhile, a key aspect in the low acceptance of analogue products is the unsatisfactory texture, appearance and aroma in the sensory properties of these products. With the best technology and increasing consumer awareness of the environmental impact of animal production, the unsustainability of the current food system and the health consequences of high meat consumption, it is believed that the acceptability of meat analogues from underutilized legumes will be improved in the coming years. A combination of different legumes to produce meat analogue could also help to improve the sensory properties and acceptability of the products.

Table 1: Proximate composition of meat analogues from soybean, cowpea and pigeon pea.

Sample s	Moisture(%)	Protein(%)	Fat(%)	Fibre(%)	Ash(%)	CHO (%)	Energy Value(k/cal)
SBM100	20.46 ± 0.06 ^c	25.91 ± 0.02 ^a	5.68 ± 0.02 ^a	0.38 ± 0.04 ^c	1.55 ± 0.04 ^b	46.01 ± 0.02 ^b	338.81 ± 0.30 ^a
CPM101	23.69 ± 0.04 ^b	19.20 ± 1.19 ^c	3.99 ± 0.47 ^b	0.81 ± 0.05 ^b	2.51 ± 0.55 ^a	49.79 ± 1.52 ^a	311.89 ± 2.17 ^b
PPM102	25.76 ± 0.05 ^a	22.06 ± 0.59 ^b	3.65 ± 0.26 ^c	1.81 ± 0.04 ^a	2.09 ± 0.02 ^b	44.63 ± 0.56 ^b	299.62 ± 0.38 ^c

SBM100= Soya bean meat analogue; CPM101= Cowpea meat analogue; PPM102=Pigeon pea meat analogue

Table 2: Sensory properties of meat analogues from soybean, cowpea and pigeon pea.

Samples	Appearance	Taste	Aroma	Mouthfeel	Texture	General Acceptability
SBM100	7.65±1.42 ^a	6.05±1.76 ^a	6.40±1.96 ^a	6.75±2.05 ^a	7.40±1.35 ^a	6.70±1.75 ^a
CPM101	5.65±1.66 ^b	6.25±1.77 ^a	5.75±1.89 ^b	5.50±2.04 ^a	6.05±1.88 ^b	6.40±1.79 ^{ab}
PPM102	5.00±2.60 ^b	5.10±2.38 ^a	4.80±1.94 ^b	5.35±2.24 ^a	5.55±1.96 ^b	5.40±2.14 ^b

SBM100=Soya bean meat analogue; CPM101= Cowpea meat analogue; PPM102=Pigeon pea meat analogue

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Data availability

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Declarations

Ethics approval and consent to participate

The author(s) declare that it is not applicable.

Consent for publication

The author(s) declare that this is not applicable.

Competing interests

The author(s) declare that they have no competing interests.

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References

1. Abebe, B.K. and Alemayehu, M.T. (2022). A review of the nutritional use of cowpea (*Vigna unguiculata*) for human and animal diets. *Journal of Agriculture and Food Research*, 10, article ID:1000383. <https://doi.org/10.1016/j.jafr.2022.100383>
2. Association of Analyst Chemist (AOAC) official methods of analysis (2023). *Official methods of analysis*. Washington D.C, USA. 22nd edition, p 806-842.
3. Bakshi, A.K., Joshi, V.K., Vaidya, D. and Sharma, S. (2013). *Food processing and preservation part-II*. Jagmandar book agency New Delhi, p.637
4. David, D., Aleksei, K., Antonella, P., Helen, V., Martti, T., Mari-Liis, T., Giacomo, S. and Carmine, S. (2020). Physico-chemical and sensorial evaluation of meat analogues produced from dry- fractionated pea and oat proteins. *Foods* 9(12):1754-1758.
5. Dedin, F.R., Dalia, E and Ulya, S. (2020). Optimization 1,2 formulation of meat analogue from cowpea (*Vigna unguiculata*) protein curds and cocoyam modification starch as filler. *Food Science and Technology* (2): 34-67.
6. Fu, Y., Chen, T., Chen, S.H.Y., Liu, B., Sun, P., Sun, H. and Chen F., (2021). The potentials and challenges of using microalgae as an ingredient to produce meat analogues. *Trends in Food Science and Technology* 112:188–200. doi: 10.1016/j.tifs.2021.03.050.
7. Gerrano, A.S., Moloafi, A., Seepe, H.A., Amoo, S. and Shimelis, H. (2022). Nutritional and phytochemical compositions and their interrelationship in succulent pods of Pigeon pea (*Cajanus Cajan L*) *Heliyon* 8, 3: e09078.
8. IITA (2024). *Cowpea Technologies for Enhancing Climate-Resillience, Food and Nutritional Security*, Benin Cotonou. The 7th World Cowpea Research Conference 23rd-26th September, 2024, <https://www.iita.org>.
9. Kołodziejczak, K., Onopiuk, A, Szpicer, A. and Poltorak, A. (2021). Meat Analogues in the Perspective of Recent Scientific Research: A Review. *Foods* 11(1):105, doi10.3390/foods11010105.

10. Luong, R.H., Winam, D.M., Shelley, M.C. and Glick, A.A. (2024). Plant-based meat alternatives predicted by theory of planned behavior among Midwest undergraduates. *Foods* 2024,13(23): 3801; <https://doi.org/10.3390/foods132333801>
11. Mihafu, F.D., Issa, J.Y. and Kamiyango, M.W. (2020). Implication of sensory evaluation and quality assessment in food product development. A review. *Current Resources in Nutrition And Food Science* 8(3):3; Doi: ; <https://doi.org/10.12944/CRNFSJ.8.3.03>
12. Singh, A. and Kumar, V., (2022). Nutritional, phytochemical and antimicrobial attributes of seeds and kernels of different pumpkin cultivars. *Food frontiers* 3(1):182-193
13. Ye, C.Y. and Fan, L. (2021). Orphan crops and their wild relatives in the genomic era. *Molecular Plant* 14(1):27-39. <https://doi.org/10.1016/j.molp.2020>

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