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Impact of varying wheat flour levels on the quality, nutritional composition and sensory properties of chicken patties

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Abstract

The demand for convenient, protein-rich meat products continues to increase due to changing consumer lifestyles and dietary preferences. Previous studies have reported that moderate levels of flour incorporation (10–25%) can improve functional properties without significantly affecting acceptability. However, limited information exists regarding the optimal level of wheat flour incorporation in chicken patties under local production conditions. This research will to contribute to the development of a healthier and appealing chicken patty products that will meet consumer preferences for quality, taste and nutritional value. This study was conducted to evaluate the effect of incorporating varying levels of wheat flour on the nutritional composition, physicochemical properties, and sensory attributes of chicken patties. A Completely Randomized Design (CRD) was used with five treatments: A (100% chicken – positive control), B (75% chicken + 25% wheat flour), C (50% chicken + 50% wheat flour), D (25% chicken + 75% wheat flour), and E (100% wheat flour – negative control). Each treatment was replicated six times. Proximate analysis showed significant differences (p<0.05) among treatments. Crude protein decreased from 38.20% in treatment A to 8.20% in treatment E, while carbohydrate increased from 3.23% to 55.30%. Cooking yield improved with increasing wheat flour, with treatment D recording the highest yield (95.56%), while cooking loss was highest in treatment A. Sensory evaluation indicated that treatments A and B had significantly higher (p<0.05) scores in tenderness, juiciness, flavour, and overall acceptability. In conclusion incorporation of wheat flour up to 25% enhanced cooking performance without significantly compromising sensory quality, making it suitable for cost-effective chicken patty production.

Keywords: Chicken patties, Wheat flour, Proximate composition, Cooking yield, Sensory evaluation.
Running title: Wheat flour inclusion in chicken patties

Impact de différentes teneurs en farine de blé sur la qualité, la composition nutritionnelle et les propriétés sensorielles des galettes de poulet

Résumé

La demande en produits carnés pratiques et riches en protéines ne cesse d'augmenter en raison de l'évolution des modes de vie et des préférences alimentaires des consommateurs. Des études antérieures ont montré qu'une incorporation modérée de farine (10 à 25 %) pouvait améliorer les propriétés fonctionnelles sans affecter de manière significative l'acceptabilité du produit. Cependant, on dispose de peu d'informations concernant la teneur optimale en farine de blé dans les galettes de poulet dans les conditions de production locales. Cette recherche vise à contribuer au développement de galettes de poulet plus saines et plus attrayantes, qui répondront aux attentes des consommateurs en matière de qualité, de goût et de valeur nutritionnelle. Cette étude a été menée afin d'évaluer l'effet de l'incorporation de différentes teneurs en farine de blé sur la composition nutritionnelle, les propriétés physico-chimiques et les caractéristiques sensorielles des galettes de poulet. Un plan d'expérience entièrement aléatoire (CRD) a été utilisé avec cinq traitements : A (100 % de poulet – témoin positif), B (75 % de poulet + 25 % de farine de blé), C (50 % de poulet + 50 % de farine de blé), D (25 % de poulet + 75 % de farine de blé) et E (100 % de farine de blé – témoin négatif). Chaque traitement a été répété six fois. L'analyse des composantes brutes a révélé des différences significatives (p < 0,05) entre les traitements. La teneur en protéines brutes a diminué, passant de 38,20 % dans le traitement A à 8,20 % dans le traitement E, tandis *que la teneur en glucides a augmenté, passant de 3,23 % à 55,30 %. Le rendement à la cuisson s'est amélioré avec l'augmentation de la proportion de farine de blé, le traitement D enregistrant le rendement le plus élevé (95,56 %), tandis que la perte à la cuisson était la plus importante dans le traitement A. L'évaluation sensorielle a indiqué que les traitements A et B présentaient des notes significativement plus élevées (p < 0,05) en termes de tendreté, de jutosité, de saveur et d'acceptabilité globale. En conclusion, l'incorporation de farine de blé jusqu'à 25 % a amélioré les performances de cuisson sans compromettre de manière significative la qualité sensorielle, ce qui en fait une solution adaptée à la production rentable de galettes de poulet.*

Mots-clés : Galettes de poulet, Farine de blé, Composition proximale, Rendement à la cuisson, Évaluation sensorielle.

Introduction

Processed poultry products such as chicken patties have gained global popularity due to their high protein content, affordability, and convenience (Khan *et al.,* 2019). Chicken meat is widely recognized for its high-quality protein, essential amino acids, vitamins, and minerals, making it an important component of balanced human nutrition (USDA, 2022). However, the increasing cost of animal protein and consumer demand for diversified meat products necessitate the incorporation of functional extenders and binders in processed meat formulations. Wheat flour is commonly used in processed meat products as a binder and extender because of its water-binding capacity, starch gelatinization properties, and gluten network formation (Miskelly, 2014). The incorporation of wheat flour into meat products can improve cooking yield, reduce production cost, and enhance structural integrity (Ikhlas *et al.*, 2011). Furthermore, wheat flour contributes carbohydrates and dietary fibre, potentially improving the nutritional balance of meat-based products. Despite these advantages, excessive substitution of meat with wheat flour may dilute protein content and adversely affect sensory attributes such as tenderness and juiciness (Ahmed *et al.*, 2020). Therefore, this study was aimed to evaluate the effect of varying levels of wheat flour on the proximate composition, physicochemical properties, and sensory characteristics of chicken patties.

Materials and Methods

Experimental location

The experiment was conducted at the Animal Production Laboratory, Department of Animal Production, Faculty of Agriculture, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria.

Preparation of chicken patties

Fresh whole chicken meat was purchased from Lapai market and transported to the Laboratory. The fresh chickens were deboned and thoroughly washed with clean water to remove any surface contaminants, chopped into smaller pieces suitable for mincing. The chickens were minced using a blender (Silver crest German industrial SC-1589) to create a uniform paste. Onion flavoured seasoning cube, salt and ground pepper were used for taste enhancement and flavour. Fresh eggs were used as an additional binder to improve the cohesiveness of the patties. Vegetable oil was used for frying the patties. Commercially available wheat flour was purchased in Lapai market and was used as a binder and extender in the patty formulations.

Formulation of chicken patty mixture

Wheat flour of different quantities: 25% (65g), 50% (131.5g), 75% (198g) and 100% (263g) were weighed and set aside. All seasonings (salt, pepper and seasoning cube) were measured according to the desired flavour profile and mixed together in a small bowl. Eggs were cracked into a separate bowl and lightly beaten. In a large mixing bowl, the minced chicken was combined with the wheat flour. The mixture was mixed thoroughly by hand until the flour is evenly distributed throughout the chicken paste (Table 1). The seasonings were added to the mixture and mixed thoroughly to ensure even distribution of flavour. The beaten eggs were added gradually to the mixture, continuing to mix until the mixture became cohesive and could hold its shape.

Table 1: Ingredients composition (g) of the patties in proportions

Ingredient (g)	Sample A	Sample B	Sample C	Sample D	Sample E
Chicken	263	198	131.5	65.0	0
Wheat flour	0.0	65.0	131.5	198	263
Egg	25	25	25	25	25
Seasoning cube	6	6	6	6	6
Ground pepper	3	3	3	3	3
Vegetable oil	2	2	2	2	2
Common salt	1	1	1	1	1
Total	300.00	300.00	300.00	300.00	300.00

Recipe modified from Olayinka *et al*,.

Experimental design

A Completely Randomized Design (CRD) was adopted with five treatments:

Treatment A: 100% chicken (positive control)
Treatment B: 75% chicken + 25% wheat flour
Treatment C: 50% chicken + 50% wheat flour
Treatment D: 25% chicken + 75% wheat flour
Treatment E: 100% wheat flour (negative control)
Each treatment was replicated six time

Shaping the patties

The chicken mixture was divided into six equal portions, each weighing 45g. Each portion was placed a small flat round shaped plate giving the patties it round shape and a uniform thickness. The shaped patties were placed on parchment paper and allowed to rest for 10-15 min before frying. This helps the patties to set and retain their shape during frying (Olayinka *et al*., 2009).

Frying the patties

A non-stick pancake puff pan was used in frying the patties to maintain it round shape. The pan was placed on medium heat with a little drop of vegetable oil in the pan. The oil was heated to 100°C as monitored by a thermometer. The patties were gently placed into the pan and fried for 10-12 minutes and flipped halfway through (Fernández-Martín *et al*., 2000)

Data Collection

Physicochemical parameters

Cooking loss

Cooking loss which is the weight loss in food due to moisture evaporation and fat or other substances released during cooking was determined using the equation thus:

Cooking loss (%) =

$$\frac{\text{weight of raw patties (g) - weight of cooked patties (g)}}{\text{weight of raw patties (g)}} \times 100$$

Cooking yield

Cooking yield was determined as the difference between 100% and values of cooking loss of each treatment (AOAC 2005). Thus; Cooking yield = (100 - % cooking loss) or

Cooking yield (%) =

$$\frac{\text{weight of cooked patties}}{\text{weight of raw patties}} \times 100$$

pH

The pH of the samples was measured by a digital pH meter (Knick-Portamess 913 pH, Berlin, Germany). The sample of 5g was mixed with 20mL of distilled water and the mixture was shaken for 3 minutes before the measurements were taken (AOAC, 2019).

Sensory evaluation

The consumer acceptance and preference were determined using 30 taste panelists who were selected randomly among students and staff of Ibrahim Badamasi Babangida University, Lapai, Faculty of Agriculture. The sensory evaluation parameters used include: tenderness, juiciness flavour, colour and overall acceptability based on a 5- point hedonic scale with 1 labelled dislike very much, and 5 labelled like very much.

Proximate analysis

Samples from the prepared patties were subjected to proximate analysis to determine the composition of carbohydrate, protein, fat, ash, crude fiber and moisture content using standard laboratory techniques (AOAC, 2019).

Data Analysis

The data obtained were subjected to one-way analysis of variance and results were reported as the means ± standard deviations. Comparison of means was done using Duncan's multiple-range test ($p < 0.05$). The Statistical Package for Social Sciences (SPSS) software version 17.0 was used to analyze the data of the sensory evaluation.

Results

Proximate Analysis

The proximate composition of chicken patties incorporated with varying levels of wheat flour is presented in Table 2. Significant differences ($p<0.05$) were observed among treatments. Moisture, ash, crude protein and fat decreased as wheat flour inclusion increased.. Crude fiber and carbohydrate increased progressively with higher wheat flour levels. Treatment A (100% chicken) recorded the highest protein and fat values, this is as a result of chicken meat containing rich protein and fat. While Treatment E (100% wheat flour) recorded the highest carbohydrate and fiber contents as a result of wheat flour being a plant product rich in crude fiber and carbohydrate .Sample E had the lowest ($p<0.05$) ash content. The ash content decreases from Sample A to Sample E. This is typical as ash represents the mineral content, which is generally higher in chicken products than in wheat.

Table 2: Proximate composition of chicken patties incorporated with varying levels of wheat flour

Treatment	Moisture content	Ash	Crude protein	Crude fiber	Fat	Carbohydrate
A	44.85^{a}	2.20^{a}	38.20^{a}	1.30^{e}	21.35^{a}	3.23^{e}
B	34.59^{b}	1.57^{b}	29.92^{b}	1.54^{d}	18.21^{b}	14.41^{d}
C	34.40^{c}	1.31^{c}	18.37^{c}	2.90^{c}	13.10^{c}	18.30^{c}
D	33.09^{d}	1.21^{d}	16.10^{d}	3.18^{b}	7.54^{d}	38.80^{b}
E	27.40^{e}	1.10^{e}	8.20^{e}	4.49^{a}	3.40^{e}	55.30^{a}
SEM±	1.88	0.12	2.88	0.39	2.20	6.21
P value	0.001	0.001	0.001	0.001	0.001	0.001

a, b, c, d: Means with different superscripts within the same column differ significantly ($p<0.05$).**Treatment A** (100% chicken - positive control), **Treatment B** (75% chicken and 25% wheat flour), **Treatment C** (50% chicken and 50% wheat flour), **Treatment D** (25% chicken and 75% wheat flour), **Treatment E** (100% wheat flour - negative control). **SEM** = Standard Error of Means.

Physicochemical Analysis

The physicochemical properties are shown in Table 3. Significant differences ($p<0.05$) were observed among treatments. Cooking yield increased with increasing wheat flour inclusion, while cooking loss decreased. The pH values showed a slight reduction as wheat flour level increased

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Table 3: Physicochemical properties of chicken patties incorporated with varying levels of wheat flour

Treatment	Cooking yield (%)	Cooking loss (%)	P^{H}
A	59.63^{e}	40.37^{a}	6.19^{a}
B	87.04^{d}	12.96^{b}	6.16^{b}
C	89.63^{c}	10.37^{c}	6.15^{c}
D	95.56^{a}	4.44^{e}	6.14^{d}
E	90.37^{b}	9.63^{d}	6.01^{e}
SEM±	1.031	1.031	0.02
P value	0.01	0.01	0.01

a, b, c, d: Means with different superscripts within the same column differ significantly ($p<0.05$).**Treatment A** (100% chicken - positive control), **Treatment B** (75% chicken and 25% wheat flour), **Treatment C** (50% chicken and 50% wheat flour), **Treatment D** (25% chicken and 75% wheat flour), **Treatment E** (100% wheat flour - negative control). **SEM** = Standard Error of Means.

Sensory Evaluation

The sensory evaluation results are presented in Table 4. Significant differences ($p<0.05$) were observed across treatments. Tenderness, juiciness, flavour and overall acceptability decreased as wheat flour inclusion increased. Treatments A and B recorded the highest sensory scores, while Treatment E had the lowest acceptability.

Table 4: Sensory evaluation of chicken patties incorporated with varying levels of wheat flour

Treatment	Tenderness	Juiciness	Colour	Flavour	Overall acceptability
A	4.87[a]	4.90[a]	4.50[a]	4.80[a]	4.87[a]
B	4.40[b]	4.13[b]	4.43[b]	4.23[b]	4.40[b]
C	3.63[c]	3.43[c]	4.07[c]	3.53[c]	3.77[c]
D	3.37[d]	2.97[d]	3.80[d]	3.07[d]	3.33[d]
E	2.63[e]	2.60[e]	3.63[e]	2.93[e]	2.90[e]
SEM±	0.097	0.098	0.088	0.088	0.085
P value	0.05	0.05	0.05	0.05	0.05

a, b, c, d: Means with different superscripts within the same column differ significantly ($p<0.05$).**Treatment A** (100% chicken - positive control), **Treatment B** (75% chicken and 25% wheat flour), **Treatment C** (50% chicken and 50% wheat flour), **Treatment D** (25% chicken and 75% wheat flour), **Treatment E** (100% wheat flour - negative control). **SEM** = Standard Error of Means.

Discussion

The incorporation of wheat flour significantly influenced the nutritional composition, cooking characteristics, and sensory properties of chicken patties. The progressive decrease in crude protein with increasing wheat flour inclusion is expected because chicken meat is a superior source of high-quality protein compared to cereal flour (USDA, 2022). Similar reductions in protein content with flour incorporation were reported by Jin *et al.* (2020) in meat patties extended with wheat flour. The increase in carbohydrate and fiber content observed in higher wheat flour treatments reflects the cereal-based composition of wheat flour (Miskelly, 2014). Wheat flour is primarily a carbohydrate source, leading to higher carbohydrate levels in formulations with greater flour content. This align with the findings of Hussain, (2017), how varying levels of wheat flour affect the carbohydrate content and overall quality of chicken patties. The ash content also increases with more chicken and decreases as wheat flour decreases, this indicates the presence of ash in chicken meat. This agrees with the findings of (weaver, 2016) which state that contains substantial amount of ash.

The improvement in cooking yield and reduction in cooking loss with increasing wheat flour levels may be attributed to the water-binding capacity and starch gelatinization properties of wheat flour (Ikhlas *et al.*, 2011). Flour acts as a binder, reducing moisture and fat losses during frying. Nurul *et al.* (2018) similarly reported improved moisture retention in flour-extended meat products. The slight reduction in pH observed with higher wheat flour inclusion aligns with previous reports that cereal flours have lower buffering capacity compared to meat proteins (Fan *et al.*, 2016).

Sensory results indicated that substitution levels above 25% negatively affected tenderness, juiciness, and flavour. This agrees with the report of Ahmed *et al.* (2020), that flour inclusion beyond 20–25% significantly reduced sensory acceptability of patties. The reduction in sensory quality at higher substitution levels may be due to dilution of meat protein matrix, which is responsible for desirable texture and flavour development (Khan *et al.*, 2019).The incorporation of wheat flour up to 25% achieved a balance between improved cooking performance and acceptable sensory quality, while higher substitution levels compromised nutritional and sensory attributes.

Conclusion

The incorporation of wheat flour up to 25% is recommended for the production of nutritionally balanced and organoleptically acceptable chicken patties suitable for consumer preference.

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