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Research Article

Quality evaluation of beef patties formulated with wheat and sweet potato flour blends

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Abstract

The use of fat replacers in meat products has been explored due to the demand for nutritious and healthy meat products. The optimal blend of wheat and sweet potato flour as healthy alternatives was investigated. Using standard procedure, samples formulated were analyzed for proximate, color, texture, sensory, and cooking properties. The cooking yield, diameter reduction and cooking loss value ranged between 56.13 - 77.27%, 10.35 - 15.03% and 18.01 - 22.72% respectively. A significant ($p < 0.05$) difference was observed in all the cooking properties of the beef patties. The color attributes of the beef patties with the inclusion of wheat and sweet potato flour were significantly ($p < 0.05$) affected by the incorporation of the flour blends. An increase was observed in protein content as the addition of wheat flour increased while the inclusion of sweet potato flour decreased fat content. The presence of sweet potato flour significantly ($p < 0.05$) affected all the textural attributes of the beef patties samples. The optimum ingredient ratio obtained was 24% wheat flour and 76% sweet potato flour. Replacing meat fat with wheat and sweet potato flour blends will produce acceptable beef patties.

Keywords

beef, patties, sweet potato flour, quality parameters, D-optimal mixture design

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Introduction

Meat and meat products are the edible part of an animal, well appreciated and eaten as food or as part of a regular diet (Marconato et al. 2020). They are a well-recognized source of protein (all essential amino acids included), and valuable nutrients such as long-chain n-3 fatty acids, antioxidants, bioactive hydrolysates, and conjugated linoleic acid (Serdarolu et al. 2018). However, consumers are increasingly becoming knowledgeable about the incidence of cardiovascular diseases linked with high consumption of processed meat products (Serdarolu et al. 2018), and demanding meat products with more nutritional and health benefits. As a result, some consumers are interested in meat products with little or no nitrite content, or replaced with natural products of health and shelf stability benefits such as spices and herbs (Balev et al. 2022; Kolev 2022). Also, there is now a greater market need for low-fat meat products, with health-enhancing ingredients such as cereal, tubers, fruits, vegetables, insects, mushrooms, egg white, whey protein and other dietary fiber-rich foods (Bunmee et al. 2022; Pintado and Delgado-Pando 2020; Serdarolu et al. 2018).

Meat patties are a convenient "ready-to-eat" and "ready-to-cook" low-fat meat product (Tolentino et al. 2021) highly consumed all over the world. They are flattened, compacted, molded, cooked ground beef or meat substitutes, widely used in the fast food and ready-to-eat meal industries. Beef is the most widely used raw meat in meat patties (Abdel-Naeem and Mohamed 2016). An acceptable and quality patty is producible by adding binders, extenders, and/or partially defatted beef fatty tissue at varying levels. Animal fat in the recipe serves as a binding and flavoring agent with significant functional and sensory importance. Fat replacers such as gums, inulin, cellulose derivatives, cereal and legume flour, and starches have been widely used as fat replacers and/or substitutes in low-fat meat products (Nasonova and Tunieva 2019; Sayed et al. 2020; Shahiri Tabarestani and Mazaheri Tehrani 2014) due to their abundance, affordability, and functionality (Eshag Osman et al. 2021).

Wheat flour has been successfully employed as a dietary fiber, stabilizer, fat replacement, binder, and volume enhancer in patties and other meat products (Jamaly et al. 2017) because of its high fiber content and solubility (Rindhe et al. 2018). However, the presence of gluten in wheat causing a chronic digestive and immune disorder (celiac disease), has prompted alternative use of non-cereal flour, such as tubers, legumes and vegetables, in a variety of baked and non-baked foods (Padmaja et al. 2012). Sweet potato flour has been studied in combination with cereal-based food products such as bread, pasta, cookies and biscuits (Adeyeye and Akingbala 2014; Ginting and Yulifianti 2015; Meng et al. 2022; Oluwalana et al. 2012; Teferra et al. 2015). This is due to their low glycemic index rating (Padmaja et al. 2012) and the enhanced physical, textural, sensory and nutritional quality of the final products. Sweet potato flour serves as a natural sweetener, dietary fiber, and energy source in baked goods and beverage products, and is also a desirable component in low-fat beef patties (Ali et al. 2011). The research aimed to evaluate the optimal influence of wheat-sweet potato flour blends on some quality attributes (cooking yield, proximate composition, color, textural, and sensory) of beef patties.

Materials and Methods

Materials. Boneless beef was obtained from a cow slaughter slab in Abeokuta, Nigeria. Fresh sweet potato tubers obtained from Lagos, Nigeria, were washed, peeled, sliced, air-dried (60℃ for 5h), milled and sieved into flour of uniform particle size (50 µm), and stored for later use. Other ingredients such as wheat flour, vegetable oil, salt, and spices were purchased from Mushin market, Lagos, Nigeria.

The boneless beef (of about 68.5% moisture, 23% protein, 1% ash, 7% fat, and 0.5% carbohydrate) was properly washed in a clean bowl, cut into smaller sizes, and minced using a manual meat mincer. After a preliminary mixing of the ingredients, minced meat (78.59%), composite flour (19.65%), spice mixture (1.18%) and salt (0.59%) gave the best recipe combination which was further used for the production of the meat patties. The mixed recipe was molded at 1.0 cm thickness using a Vernier caliper to ensure uniform thickness, deep-fried at 165℃ for 5 min, cooled at room temperature (22 - 25℃) for 30 min, packed in Ziplocs, and stored at 4℃ before analysis.

Two level- two-factor full factorial design-two independent variables at two levels each (upper and lower levels); wheat flour (20 - 40%) and sweet potato flour (60 - 80%). A total of nine experimental combinations were obtained and used to investigate their effects on the responses generated using Design-Expert (Stat-Ease, 11.0, Inc. Minneapolis, Minnesota). Analyses were carried out in duplicate, hence, the values presented are means of two experiments for each run. The data were fitted to quadratic polynomial models to obtain the regression equations. Analysis of variance was used to examine the statistical significance of the terms in the regression equations for each response at $p < 0.05$. Quadratic models were fitted to the data and the adequacy of the model was checked based on the values of R^2. A numerical optimization method was used to obtain the optimal ingredient mix based on the concept of desirability.

Methods. The dimensional shrinkage of the beef patties was determined according to (Hawashin et al. 2016). The weight of the raw beef patties was measured before and after frying, and calculated

$$Dimensional\ shrinkage = \frac{Raw\ patty\ measurement - cooked\ patty}{Raw\ patty\ measurement} \times 100$$

The cooking yield was determined to observe the effect of composite flour on the water take-up of the samples. This was measured by calculating the difference in the sample weight before and after cooking. Neel et al. (2017) outlined that cooking loss can be determined by blotting extra moisture from the meat samples and weighing the samples accurately before cooking. After cooking, the samples were allowed to cool, extra moisture blotted, and weighed immediately. The cooking loss (%) was the difference in the weights of the sample before and after cooking. The proximate composition of the beef patties were determined using AOAC (2005) methods. The total percentage of carbohydrates was calculated by difference.

The texture properties of the fried beef patties samples were determined using the puncture testing machine (Model: M500-100AT, Manufacturer? capacity: 100kN). Fried beef patties of uniform size were selected, and a 6-pin probe was allowed to penetrate the fried beef patties up to a specified depth at a crosshead speed of 10 mm/min. The samples were punched once on each side, then the beef patties' gumming, cohesion, and hardness were determined (Qiao et al. 2007). The lightness (L^*), redness (a^*) and yellowness (b^*) of the beef patties was measured in triplicate as described by (Nadim et al. 2015), after calibration of the instrument (Chroma-meter CR-410, Minolta, Japan) using a white tile. The average values of the results obtained were expressed in accordance with the CIELAB system.

The sensory characteristics and acceptability of the beef samples was assessed for color, texture, flavor, aroma, taste, and overall acceptability using a seven-point hedonic scale. Thirty untrained panelists consisting of staff and students of the Department of Food Technology, Yaba College of Technology participated in the assessment. Participants were provided with written informed consent about the assessment, and water was provided to rinse the palate between samples.

Data obtained from the study were statistically analyzed for the significant effect of the independent variable on the responses at a 5 % level using analysis of variance (ANOVA) of SPSS version 21. The effect of ingredient combination and optimization procedure was also investigated using Design expert based on simplex centroid design.

Results and Discussion

Effect of wheat flour and sweet potato flour on the cooking properties of the beef patties. The result of the cooking characteristics of the beef patties (Table 1) ranges from 65.13 - 77.27 % for cooking yield, 10.35 - 15.03 % diameter reduction, and 18.01 - 22.72 % cooking loss. The result indicates substitution percentage has a significant ($p \leq 0.05$) effect on the cooking yield of the beef patties. At the highest level of substitution, beef patties made with the highest percentage (80%) of sweet potato flour had the highest value in terms of cooking yield (77.19 - 77.27 %).

This observation corresponds with the work of Ergezer et al. (2014) where it was reported that increasing the inclusion of potato puree in beef patties increased the cooking yield. The differences in our results could be associated with the utilization of the composite blends of wheat and sweet potato, which resulted in good retention of fluids in the meat matrix (Serdaroğlu et al., 2017). The increase in the cooking yield might be due to water holding capacity and water retention properties attributed to sweet potato flour. The report of Khalil (2000) and Verma et al. (2015) also showed that cooking yield improved upon the replacement of fat with starch and water combinations in cooked patties.

Table 1. Effect of incorporation of wheat and sweet potato flour on the cooking properties of beef patties

Samples	Wheat flour	Sweet potato flour	Cooking yield, %	Diameter reduction, %	Cooking loss, %
1	30	70	70.03±0.01[e]	13.23±0.01[e]	20.03±0.01[e]
2	20	80	77.27±0.01[h]	10.38±0.01[b]	18.03±0.01[b]
3	35	65	67.23±0.01[d]	14.25±0.01[f]	21.01±0.01[f]
4	40	60	65.13±0.01[a]	15.01±0.01[h]	22.72±0.01[i]
5	40	60	65.71±0.01[c]	15.03±0.01[i]	22.68±0.01[h]
6	40	60	65.56±0.01[b]	14.58±0.01[g]	22.56±0.01[g]
7	30	70	70.04±0.01[e]	13.17±0.01[d]	18.01±0.01[a]
8	25	75	75.02±0.01[f]	12.02±0.01[c]	18.45±0.01[c]
9	20	80	77.19±0.01[g]	10.35±0.01[a]	20.00±0.01[d]

Data are presented as the mean values of triplicates ± standard deviation.
Means with the different letters in the same column are significantly different ($p \leq 0.05$)

Furthermore, yield in meat and meat products is related to fat and water retention (Aleson-Carbonell et al. 2005), differences in the cooking yield of each sample may be related to the water absorption levels of the non-meat ingredient used. Dimensional change is one of the most important changes common in meat patties, and this can be affected by the incorporation of new ingredients. Increasing the substitution level of wheat flour with sweet potato flour decreased the shrinkage or diameter reduction of the beef patties. In other words, an increase in sweet potato flour caused less diameter reduction of the beef patties, which means less water and fat loss during the cooking process (Pintado and Delgado-Pando 2020). Protein denaturation, moisture and fat release of products are some of the main diameters-reducing effects during cooking (Soltanizadeh and Ghiasi-Esfahani 2014). A significant ($p \leq 0.05$) difference exists between the diameter reductions of all the beef patty samples, however, beef patties with the highest shrinkage value (14.58 - 15.03%) were those made with 40 : 60% wheat: sweet potato flour. Beef patties made with a high quantity of sweet potato flour yield a significantly ($p \leq 0.05$) lower cooking loss, which is an indication that sweet potato flour has a good water-holding capacity, and its starch, protein and fiber contents have a big impact on the water-holding capacity of the meat patties (Pintado and Delgado-Pando 2020).

Color attributes of wheat and sweet potato flour incorporation in beef patties. Color is one of the most essential factors in consumers' attitudes toward meat and meat products (Serdaroğlu et al. 2017), as it influences purchase decisions. The lightness (L*), redness (a*) and yellowness (b*) of the beef patties with the inclusion of wheat and sweet potato flour blends ranged from 28.24 to 31.06; 7.49 to 9.06 and 7.73 to 9.95 respectively. Beef patties sample with the inclusion of a 30 : 70 wheat : sweet potato flour ratio had the highest values (30.75 - 31.06, 9.05 -9.06, 9.93 - 9.95) in terms of lightness, redness, and yellowness, respectively. The trend of color intensity as influenced by the flour blend substitution ratio in the beef patties samples is shown in Fig. 1a-c.

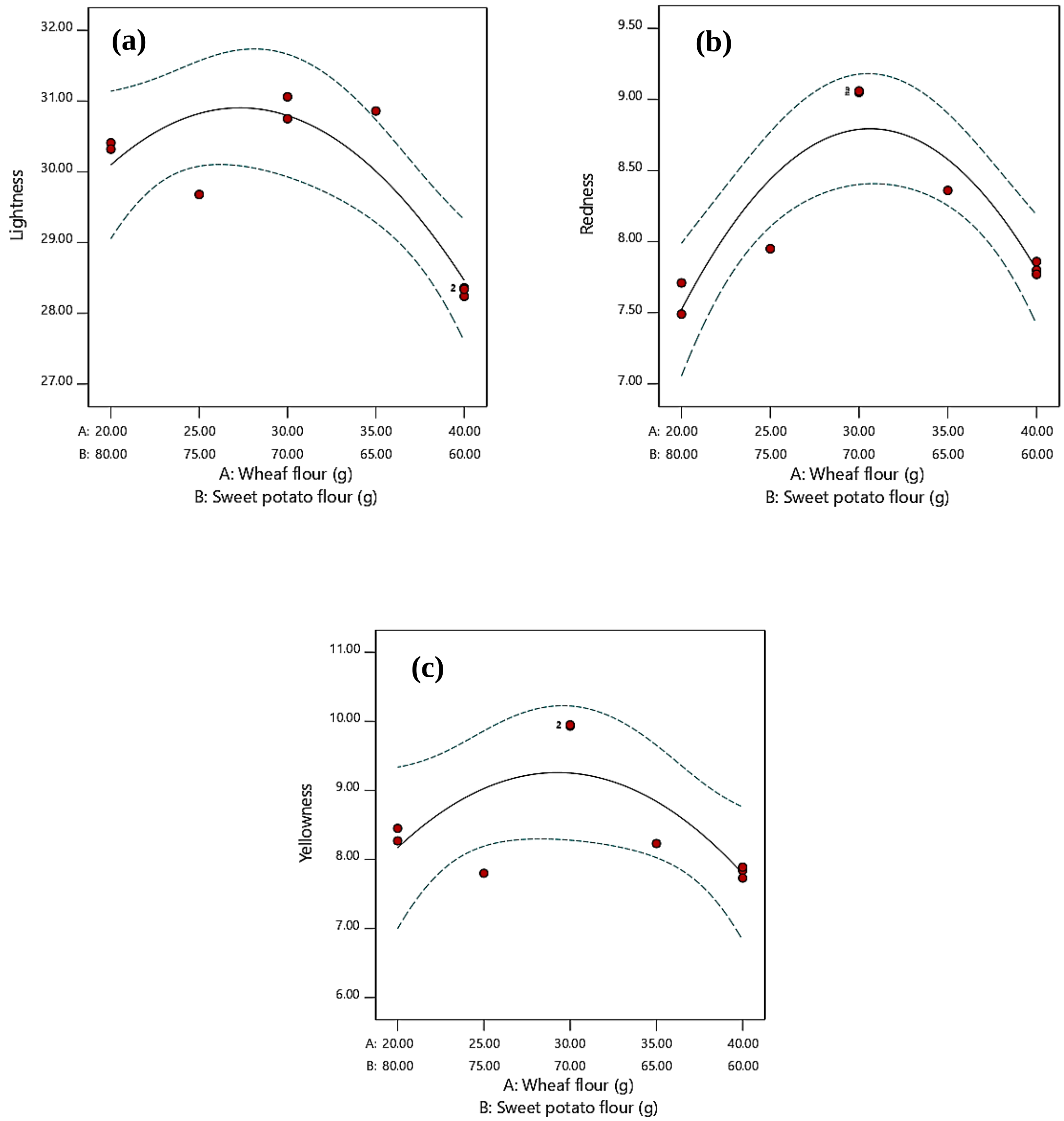

Figure 1. Model graph depicting the trend of a) lightness (b) redness and (c) yellowness of the beef patties as influenced by wheat and sweet potato flour substitution ratio

As the inclusion of sweet potato flour increased, there was an increase in the value of lightness and yellowness of the beef patties, but the redness of the beef patties decreased as sweet potato flour increased.

The lightness and redness values were significantly ($p \leq 0.05$) affected by both the main and interaction effects of sweet potato and wheat flour, however, only the main effect of sweet potato and wheat flour had a significant ($p \leq 0.05$) effect on the yellowness of the samples.

Reduction in the color can be attributed to a dilution effect of meat pigments by non-meat ingredients in the meat products formulation as reported in the literature (Ali et al. 2011; Cofrades et al. 2004). Also, the variation in color attributes may be due to a non-enzymatic browning reaction between reducing sugars present in the sweet potato powder, and the protein in meat during cooking. The yellow color of sweet potatoes presumably increased the yellowness values of all the beef patties (Verma et al. 2015).

Furthermore, Table 2a shows the coefficients of determination (R^2) for lightness, redness and yellowness, which were 0.79, 0.83 and 0.52, respectively. These values are quite high for response surfaces and showed that the fitted quadratic models accounted for more than 95% of the variance in the experimental data, which turned out to be highly significant. The results from the statistical analysis revealed that the F-value for lightness (11.03), redness (14.30) and yellowness (3.29) were significant at the 95% confidence level.

Table 2a. Regression coefficient of color attributes for the beef patties

Parameter	Lightness	Redness	Yellowness
A: Wheat flour	28.47*	7.80*	7.79*
B: Sweet potato flour	30.10*	7.52*	8.17*
AB	6.05*	4.51*	5.08
R^2	0.79	0.83	0.52
F-Value	11.03	14.30	3.29

AB – Interaction of wheat and sweet potato, R^2 – Coefficient of determination

Table 2b. Regression coefficient of textural properties for the beef patties

Parameter	Hardness	Adhesiveness	Cohesiveness	Chewiness	Gumminess
A: Wheat flour	20.02*	0.011	0.48*	6.48*	9.53*
B: Sweet potato flour	17.14*	0.313	0.41*	3.13*	6.84*
AB	-7.57	3.22	-0.21	-5.33*	-3.85
R^2	0.33	0.51	0.54	0.93	0.52
F-Value	1.45	3.12	3.46	37.32	3.22

AB – Interaction of wheat and sweet potato, R^2 – Coefficient of determination

Textural attributes of beef patties with wheat-sweet potato flour incorporation. The textural properties of meat and meat products are closely related to the functionality of muscle proteins and the presence of non-meat ingredients. The results of the hardness, adhesiveness, chewiness, cohesiveness, and gumminess of the fried beef patties were between 12.18 to 21.68N; 0.01 to 1.53N.s; 2.66 to 7.37N; 0.32 to 0.50 and 4.97 to 10.43N respectively. The trend of the textural properties as influenced by the flour blend substitution ratio is shown in Fig. 2a-e. As the inclusion of sweet potato flour increased, the hardness of the beef patties decreased significantly. However, the interaction of wheat and sweet potato flour had no significant ($p \leq 0.05$) effect on hardness.

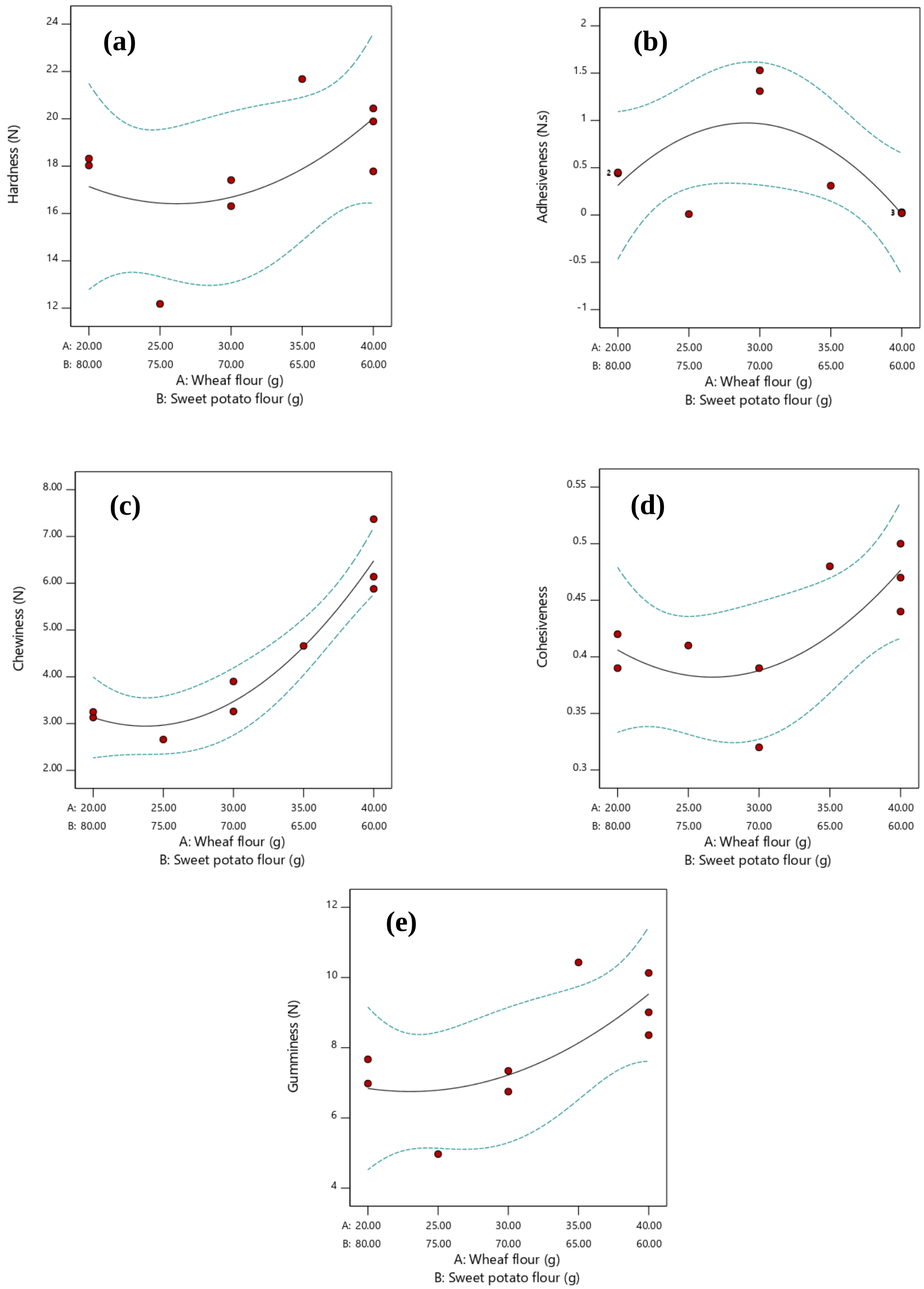

Figure 2. Model graph depicting the trend of (a) hardness, (b) adhesiveness, (c) chewiness, (d) cohesiveness, and (e) gumminess of the beef patties as influenced by wheat and sweet potato flour substitution

Adhesiveness value on the other hand increased initially as sweet potato flour was added, but further decreased at a higher inclusion rate.

Chewiness, cohesiveness, and gumminess decreased with an increase in sweet potato flour inclusion. The main effect of wheat and sweet potato flour, as well as their interactions, had a substantial impact on the chewiness, however, the main effects of wheat and sweet potato flour affected cohesiveness and gumminess significantly. During cooking or frying of the patties, heat-induced gelation of myofibrillar proteins is critical to delivering product integrity and needed texture and sensory properties (Shen et al. 2022). The increase in the hardness attributes of patties may be due to the change of binding blocks between meat pieces and gelation in the system due to interactions between the meat and non-meat proteins (Youssef and Barbut 2011).

Similar results were found in beef patties with pea protein and emulsified meat patties with soy protein (Baugreet et al. 2016; Youssef and Barbut 2011). The addition of non-meat ingredients to beef patties decreased the majority of the texture properties, this corresponds to the results of Verma et al. (2015) on low-fat pork patties where sweet potato flour and water were used as fat substitutes. The addition of non-meat ingredients in a meat protein system often results in a dilution effect, which weakens the protein network formation contributing to the textural properties changes (Jairath et al. 2018). Again, as seen in Table 2b, the coefficients of determination (R^2) for hardness, adhesiveness, chewiness, cohesiveness, and gumminess are 0.33, 0.51, 0.54, 0.93, and 0.52, respectively. The results from the statistical analysis revealed that the F-value ranged from 1.45 to 37.32 and was significant at the 95 % confidence level.

Proximate composition of the beef patties with wheat and sweet potato flour. The results of the proximate composition of beef patty samples are shown in Table 3a. The moisture content ranged significantly from 24.07 to 30.79 %, with beef patties with a 20:80 % wheat: sweet potato flour ratio having the highest value. These values are lower than those reported (55 - 77%) for cooked beef patties (Khalil, 2000; Serdarolu et al. 2018), indicating a better keeping quality product. An increase in the sweet potato flour addition caused an initial decrease in the moisture content of the beef patties, which further increased with an increase in the quantity of the sweet potato flour. The higher pH of the product and hygroscopic/water-holding capability of the sweet potato flour may be implicated in the observed rise in moisture content. Many researchers (Ali et al. 2011; Kang et al. 2012; Verma et al. 2015) who added various fat substitutes, such as potato flakes, or oat flour, to the beef products, reported similar results.

The crude protein content of the beef samples ranged from 15.24 to 23.64%, with beef patties with 30% wheat and 70% sweet potato flour having the least while patties with 40% wheat and 60 % sweet potato flour having the highest value. There was a decrease in the crude protein content of the beef patties as the amount of sweet potato flour in the blend was increased. This observation is similar to that reported by Naveena et al. (2006) in chicken patties formulated with different levels of *Ragi* millet flour. The crude fat content of the samples significantly ($p \leq 0.05$) ranged from 7.08 to 10.74%, with beef patties made with 30 : 70% wheat: sweet potato flour having the least value, and with 40 : 60% wheat: sweet potato flour ratio the highest. Substitution of wheat flour by increasing the quantity of sweet potato flour in the flour mixture decreased the fat content of the beef patties produced. The percentage of fat in final products is less than 12%, which is under the prescribed limit/standard for low-fat meat products (Verma et al. 2015).

The total ash content of the beef patties decreased significantly ($p \leq 0.05$) from 2.23% to 1.76% as sweet potato flour substituted wheat flour. Beef patties with 40 : 60% wheat: and sweet potato flour had the highest ash content. In addition, the crude fiber content of the samples ranged between 0.14 and 0.40%. The crude fiber content decreased slightly as the quantity of sweet potato flour was increased, but there is no significant ($p \geq 0.05$). difference between the beef patties.

Table 3a. Proximate composition of the formulated beef patties

Samples	Wheat flour, g	Sweet potato flour, g	Moisture, %	Proteins, %	Fats, %	Ash, %	Fibers, %	Carbohydrates, %
1	20	80	30.79 ±0.01[i]	20.57±0.01[c]	7.81±0.01[d]	2.06 ±0.01[d]	0.19±0.01[a]	38.58±0.01[c]
2	20	80	30.72±0.01[h]	21.01±0.01[d]	7.67±0.01[c]	1.92±0.01[b]	0.20±0.01[a]	38.48±0.01[c]
3	25	75	26.89±0.01[d]	22.65±0.01[e]	7.66±0.01[c]	1.76±0.01[a]	0.15±0.01[a]	40.89±0.01[d]
4	30	70	24.43±0.01[b]	15.24±0.01[a]	7.08±0.01[a]	1.99±0.01[c]	0.14±0.01[a]	51.12±0.01[g]
5	30	70	24.52±0.01[c]	16.01±0.01[b]	7.34±0.01[b]	1.93±0.01[b]	0.15±0.01[a]	50.05±0.01[f]
6	35	65	24.07±0.01[a]	23.08±0.01[f]	7.84±0.01[e]	2.16±0.01[e]	0.40±0.01[a]	42.59±0.01[e]
7	40	60	29.26±0.01[e]	23.64±0.01[g]	10.74±0.01[h]	2.23±0.01[g]	0.20±0.01[a]	33.93±0.71[a]
8	40	60	29.67±0.01[g]	23.08±0.01[f]	9.00±0.01f	2.17±0.01[e]	0.19±0.70[a]	35.89±0.01[b]
9	40	60	29.43±0.01[f]	23.36±0.01[h]	10.35±0.01[g]	2.21±0.01[f]	0.20±0.01[a]	34.45±0.01[a]

Data are presented as the mean values of triplicates ± standard deviation.
Means with the different letters in the same column are significantly different ($p \leq 0.05$)

Table 3b. Regression coefficient of proximate composition for beef patties formulated with wheat and sweet potato flour blends

Parameter	**Moisture**	**Proteins**	**Fats**	**Ash**	**Fibers**	**Carbohydrates**
A: Wheat flour	29.27*	23.60*	9.96*	2.22	0.20*	34.74*
B: Sweet potato flour	30.97*	21.32*	7.86*	1.95	0.20*	37.71*
AB	-23.35*	-16.71	-6.58*	-0.58	-0.01	47.34*
R^2	0.96	0.51	0.85	0.74	0.64	0.86
F-Value	74.07	3.06	16.88	8.35	2.98	18.42

AB – Interaction of wheat and sweet potato, R^2 *– Coefficient of determination*

The carbohydrate content of the beef patties ranged from 33.93 to 51.12%. There was a significant ($p \leq 0.05$) difference between the carbohydrate content of the beef patties. Adding sweet potato flour increases the beef patties' carbohydrate content by 60 to 70%, this is because sweet potato flour has higher carbohydrate content than meat and a high carbohydrate content is directly proportional to the energy content of the food product.

Table 3b presents the quadratic regressions of the data obtained. The main effect of wheat flour and sweet potato had a significant ($p \leq 0.05$) effect on the moisture content. The interactive effect of the two flour blends had a negative effect on moisture content. The regression coefficient parameter showed that the quadratic model developed for moisture content had a coefficient of determination (R^2) of 0.96 indicating a 96% predictive accuracy and an F-value of 74.04. The main effect of wheat flour and sweet potato had a significant ($p \leq 0.05$) effect on protein content respectively. The interactive effect of the flour sample had no significant ($p \geq 0.05$) effect on protein content. The regression coefficient parameter showed that the quadratic model developed for protein content had a coefficient of determination (R^2) of 0.51 indicating a 51% predictive accuracy and an F-value of 3.06.

The main and interactive effects of wheat and sweet potato flour had a significant ($p \leq 0.05$) effect on the fat and crude fiber content of the samples. The regression coefficient parameter showed that the quadratic model developed for fat and crude fiber content had a coefficient of determination (R^2) of 0.85 and 0.64 indicating 85% and 64% predictive accuracy, and an F-value of 16.88 and 2.98, respectively. The main effect of wheat flour and sweet potato flour had a significant ($p \leq 0.05$) effect on total ash and carbohydrate content respectively. The interaction effect of the flour blends was also statistically significant ($p \leq 0.05$). The quadratic model gave an F-value of 8.35 and 18.42, and a coefficient of determination (R^2) of 0.74 and 0.86, which indicates a 74% and 86% predictive accuracy of the total ash and carbohydrate contents respectively.

Optimized solution of the ingredient formulation. The numerical optimization procedure was used to find the best wheat-sweet potato flour blend after setting varying goals for the quality attributes of meat patties. The flour sample (wheat and sweet potato flour) goals were set to be in range; moisture, fat content, adhesiveness, chewiness, and gumminess goals were minimized; while protein, lightness, and texture (hardness and cohesiveness) goals were maximized. After running the goals with the responses, the desirability with the highest value was selected. Wheat flour (24%) and sweet potato flour (76%) was selected with a calculated desirability of 0.61.

Sensory evaluation of beef patties. The results of the mean sensory scores for the beef patties produced with 100% wheat flour, 100% sweet potato flour, and the optimized flour blend are summarized in Table 4.

Table 4. Sensory evaluation of beef patties

Sensory attributes	Optimized sample	100% wheat flour	100% sweet potato flour
Appearance	7.04 ± 0.01^b	7.24 ± 0.01^c	6.92 ± 0.01^a
Flavor	7.21 ± 0.01^b	7.12 ± 0.01^b	7.09 ± 0.01^a
Texture	7.14 ± 0.01^b	7.18 ± 0.01^c	7.09 ± 0.01^a
Juiciness	7.11 ± 0.01^c	7.04 ± 0.01^b	6.98 ± 0.01^a
Overall acceptability	7.16 ± 0.01^c	7.05 ± 0.01^b	6.99 ± 0.01^a

Means bearing different superscripts in a row differ ($p < 0.05$)
Optimized sample (24g of wheat flour and 76g of sweet potato flour)

All the scores obtained were between 6.92 and 7.21 and showed a significant ($p \leq 0.05$) difference among the parameters measured. The appearance score of the beef patties with 100% wheat flour was found to be the highest among the three samples. The optimized beef patties sample (containing 24% wheat and 76% sweet potato flour) had the highest scores (7.21) in flavor, which may be due to the impact of the fat content of the optimized sample.

Fat also strongly influences the texture and juiciness of meat products, hence its influence on the high score (7.18) of the 100% wheat flour beef patties texture, followed by the optimized beef patties (7.14). The juiciness score was the highest for the optimized sample (7.11), indicating that the incorporation of wheat and sweet potato blends enhanced this parameter in the beef patties. This could be due to the greater moisture retention and water-binding properties of sweet potato flour. There was a significant ($p \leq 0.05$) difference among all the beef patties in overall acceptance, with the optimized sample having the highest scores followed by beef patties with 100% sweet potato flour.

The score of the assessments for appearance, texture, juiciness, flavor, and overall acceptance was generally found to be above moderately desirable. These findings suggested that sweet potatoes enhanced the qualities of patties and had a significant impact on the overall acceptance scores. The optimized beef patties were chosen by the panelist and obtained the highest acceptability scores when compared to the alternatives, whereas patties composed entirely of sweet potatoes received the lowest acceptability scores.

Conclusion

In the concept of developing healthier meat products, this study experimentally designed the mix of wheat and sweet potato flour and used it as fat replacer in beef patties production. Results showed that the flour blends significantly changed the cooking characteristics of the beef patties. Sweet potato flour addition enhanced color and texture profile of the samples significantly except for adhesiveness. The flour blends also improved the proximate content of the patties. Taste panelists during the sensory assessment revealed the significant ($p \leq 0.05$) differences observed in the appearance, texture, flavor, juiciness and overall acceptance of beef patties. The optimized sample were most preferred for flavor, juiciness and overall acceptability. In this sense, blend of 24 g of wheat flour and 76g of sweet potato flour is acceptable for incorporation in beef patties.

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