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RESEARCH ARTICLE

Sensory Acceptability of Food Products from Wheat and Pigeon Pea (Cajanus cajan) Composite Flours in Kenya

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Abstract

Pigeon pea provides protein, minerals, B vitamins, vitamin C and fibre, and has great untapped potential; its flour can enrich wheat snacks and contribute to less utilization of wheat flour hence reducing foreign exchange used on wheat imports. Little is known about products that can be made from composite pigeon pea-wheat flour and their sensory characteristics. This study aimed to develop cake, cookies and *chapatti* from 0%, 5%, 10% and 20% wheat and pigeon pea composite flours and evaluate their sensory acceptability. This was done in Chuka and Tharaka sub-Counties, in Central Kenya region amongst 85 community members, corroborated using eight (8) expert sensory panelists and a focus group discussion. Quantitative data were analyzed using one-way Analysis of Variance, and thematic analysis on qualitative data. Significant differences ($P<0.05$) existed between 20% blend and the other levels for most characteristics in cake, while cookies showed significant differences for some characteristics in R10%, R20% and R5%. In *chapatti,* R20% showed significant differences ($P<0.05$) in color and taste (trained panelists) and in smell, general acceptability and intention to purchase (consumer panelists). Focus group discussion showed P10% cake, control cookies and P10% *chapatti* as most preferred while roasting caused burnt taste/smell. This study shows that precooked pigeon pea flour can be composited with wheat flour to process cake, cookies and *chapatti*. Future studies should investigate the nutrient content, effect of processing on anti-nutrient levels, shelf life and cost-benefit analysis of the products.

Keywords: Composite, Pigeon Pea, Products, Sensory, Wheat.

1. Introduction

The blending of wheat flour with ingredients from various sources especially legume flour has been explored by researchers and is continually attracting much attention, especially in the production of pastries and bakery products (Okalanmi et al., 2022). The composite flours have been found to produce products that still maintain characteristics similar to those in full-wheat products (Noorfarahzillah et al., 2014). The baking industry is moving into fortification or complete substitution of wheat flour with nutritious ingredients, including legumes (e.g. soya, faba bean, chickpea, lupin, and cowpea), to make nutrient-dense breads (Wang et al., 2021). Composite technology is also advantageous because it contributes to reducing or even eliminating the huge amount of money spent on wheat flour importation (Nwanekezi, 2013).

Complementing cereal-based foods with legumes has received considerable attention since the latter have much higher nutrients and are an excellent source of many essential nutrients, including vitamins, minerals, fibres, antioxidants and other bioactive

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compounds (Amarowicz, 2020). Legumes are an inexpensive alternative to meat (Maphosa & Jideani, 2023) and hence affordable by many families in low- and medium-income countries; it therefore, stands in the gap to ensure that protein is not omitted entirely in meals consumed in these families.

Pigeon peas (*Cajanus cajan*) is a widely grown legume in Africa and beyond (Kaoneka t al., 2016) and has been used as a substitute for wheat flour in improving the nutrient content of snack products, including lowering the glycemic index of biscuits (Eneche, 1999) as well as increasing the protein and crude fibre contents of bread (Olanipekun et al., 2018) and crackers (Olagunju et al., 2018). This substitution of pigeon pea flour in all-wheat flour snacks has produced healthy food products with a low glycemic index that is important in controlling sugar levels in diabetics (Gbenga-Fabusiwa et al., 2019). Substituting whole wheat flour with pigeon pea flour also produced *chapatti* (an unleavened flat bread) with reduced starch and higher protein digestibility, as well as exhibiting reduced glucose release hence a low glycemic index (Sachanarula et al., 2022).

Pigeon pea is a hardy, annual crop with higher tolerance to drought and high temperatures compared to most other crops (Akande et al., 2010). It is grown to provide food security, for agroforestry, income generation as well as livestock feed (Kaoneka et al., 2016). It is a rich source of starch, protein, calcium, manganese, crude fibre, fat, trace elements and minerals. As well, it has medicinal use in various nations including India, China and the Philippines and can prevent and cure several respiratory infections, dysentery, menstrual disorders, wounds, abdominal tumours, and diabetes among others (Faris & Singh, 1990). This has been attributed to the presence of polyphenols and flavonoids which are plant secondary metabolites (Singh & Basu, 2012). Pigeon pea is a good source of water-soluble vitamins such as thiamine, riboflavin, niacin and vitamin C; provides minerals like phosphorus, magnesium, iron, calcium, sulphur and potassium (Kunyanga et al., 2013). Besides its rich nutrition base, pigeon pea has medicinal properties.

Little has been done to establish the effect of substituting wheat flour with pigeon pea flour on the consumer acceptability of common snack foods in the Kenyan market today. This research assessed the sensory acceptability of cake, cookies and prepared from various blending levels of wheat and precooked and roasted pigeon pea composite flours.

2. Materials and Methods

2.1 Preparation of Pigeon Pea Flour

A local variety of pigeon pea, *Kendi*, was sourced from the municipal market in Chuka town, processed using precooking and roasting then milled into flour using a laboratory grinding machine. The flour was used to prepare different blending levels of composite flours used to prepare four products, i.e. cake, cookies and *chapatti*.

2.1.1 Precooked Pigeon Pea Flour

Pigeon peas were boiled in water at 100^{O}C for 40 minutes from the time boiling started using a ratio of one kg of pigeon peas to five L tap water. The water was then drained and the pigeon peas were removed and dried in an enclosed solar drier for 72 hours before milling into flour.

2.1.2 Roasted Pigeon Pea Flour

One kilogram of clean pigeon peas was dry roasted at a time in an aluminium saucepan using a high heat option in a range cooker top hot plate (approximately 260^{o}C). Roasting was done for 50 minutes with constant stirring (Adegunwa et al., 2012). These were then milled into flour using a Teflon-coated mill in the food science laboratory and stored in airtight plastic containers awaiting use.

2.2 Preparation of Composite Flours

The two types of pigeon pea flour were used i.e. pre-cooked pigeon pea flour and roasted pigeon pea flour. Five kilograms each of three composite flour levels were prepared as follows: 5% level consisting of 5% (250g) pigeon pea flour and 95% (4750g) all-purpose wheat flour; 10% consisting of 10% (500g) pigeon pea flour and 90% (4500g) wheat flour; and finally 20% consisting of 20% (1000g) pigeon pea flour and 80% (4000g) wheat flour.

2.3 Products' formulation

All other ingredients needed were acquired from a local supermarket. Ingredient portions for the recipes were based on 400g flour. All the other ingredients were held constant. A control of 100% wheat flour plus the three composite flours was used to produce four blending levels.

2.3.1 Preparation of Cake

The ingredients were 400g flour from each of the four levels, 200g margarine, 200g sugar, 10g baking powder and three eggs. The flour and baking powder was sifted, and the margarine was rubbed in followed

by sugar addition and mixing. Eggs were then beaten, added to the mixture and mixed thoroughly. The mixture was poured into tins and baked at 135°C for 35 minutes until the cake developed a distinct scent and golden brown crust.

2.3.2 Preparation of Cookies

The ingredients were 400g flour from each level, 160g butter, 40g shortening, two eggs, 200g sugar and ½ teaspoon salt. Butter and shortening were mixed using a wooden spoon until uniform. Sugar was added and mixed until the ingredients were light and fluffy. Eggs were added and the mixture was stirred until the ingredients were well combined. The flour, baking powder and salt were whisked together in a separate bowl and ⅓ of the dry ingredients were added to the wet ingredients and stirred until just combined. Dry ingredients were gradually added continuously while stirring. The oven was pre-heated to 205°C. The dough was scooped out using a tablespoon and shaped into balls using clean hands. Each ball of dough was placed onto a baking sheet lined with parchment paper, leaving about five cm of space all around for spreading as it cooked. The cookies were baked for 10 minutes, removed from the oven, cooled for two minutes then loosened using a spatula and cooled on wire racks.

2.3.3 Preparation of Chapatti

The ingredients were 400g of flour from each level, 500 ml of cooking oil, 150 ml of water and 2.5 g of salt. The flour and salt were mixed; water was added and mixed using a wooden spoon until the mixture left the spoon, then kneaded using hands until uniform. Ten ml oil was added, kneaded again then cut into small uniform pieces and rolled flat and thin. These were fried on a pan in little oil until both sides turned golden brown and were cooked.

2.4 Sensory Evaluation

The cooled products were packed in airtight clear plastic containers and kept at room temperature awaiting evaluation. For staggering purposes, products prepared in the morning were evaluated the same day beginning from 12.30 PM, and the rest the following day, same time. Each product was cut into 3 cm x 1 cm x 1 cm pieces and placed on coded plates all lined with white serviettes. A pretest involved 17 second-year hospitality students (six males and 11 females) of Chuka University who would then not form part of the study. The reliability test gave a Cronbach's Alpha value of 0.880 hence the research tool was considered reliable.

Affective tests involved eight expert sensory assessors (Food Science Teaching Staff of Chuka University)- these have a high degree of sensory acuity, are experienced in test procedures, with ability to make consistent sensory assessments. Since they are familiar with the quality of various products, they are, therefore, capable of discriminating differences and communicating their reactions. Highly trained experts are involved in sensory evaluation to minimize the effects of a mixed study sample (Jain & Gupta, 2005). The consumer panel consisted of 85 community members within Chuka University fraternity/ neighborhood and Tharaka sub-county community. Representation of various occupations and age groups was sought. Extreme ages were avoided (younger than 18 years and above 55 years old) for good sensory judgment (Guinard, 2000; Linford et al, 2010). The exercise was carried out in the Food Science laboratory at Chuka University, each in a separate booth to avoid distraction from other panelists. Panelists rinsed the mouth with thorough water after tasting each sample (Jain and Gupta, 2005).

A five-point hedonic scale (1=dislike very much, 2=moderately dislike, 3=neither like nor dislike, 4-like moderately and 5=like very much) was used to evaluate the products for color, texture, taste, smell and general acceptability. A focus group discussion (FGD) was then carried out involving 12 community members in the Tharaka sub-county; men and women who included both youths and middle-aged of various occupations. The FGD was aimed at providing in-depth information on the samples' characteristics while establishing the reasons behind the acceptability (or lack thereof), dwelling on the level that was liked very much and the level disliked very much.

2.5. Statistical Analysis

Data were subjected to One-way Analysis of Variance to compare means, and significantly different means separated by Tukey's post hoc test, at $\alpha = 0.05$, using SPSS version 20 (Kirkpatrick & Feeney, 2012). Qualitative data from the FGD was analysed through thematic analysis by systematically identifying and organizing the patterns of meaning across the dataset (Braun & Clarke, 2012).

3. Results

3.1 Respondents' Characteristics

Eight (8) trained panelists and 85 consumers of whom 40 (47.1%) were female and 45 (52.9%) males responded. Table 1 shows that the majority of them (50.6%) were aged between 21-25 years followed by 17.8% aged between 31-35 years.

Table 1. *Age Distribution of Untrained Taste Panelists*

Age (years)	18-20	21-25	26-30	31-35	31-40	41-45	46-50	51-55	Total
Frequency	4	43	5	12	8	4	5	4	**85**
Percent (%)	4.7	50.6	5.9	14.11	9.41	4.7	5.9	4.7	**100**

Respondents' occupations included teaching, administrative (Admin) and supportive staff and students of Chuka University (CU), students from a nearby Kenya Medical Training College (KMTC), and form four students from a neighboring secondary school. In Tharaka sub-county panelist included farmers, casual laborers and students from Tharaka Technical and Vocational College. Table 2 below indicates that the respondents were representative of the community members although the majority were students.

Table 2. *Respondents (%) by Place and Occupation of the Taste Panelists*

	Admin. Assistant/ Formal Employment	Casual Labour	Secondary/ KMTC/ CU Student	Cleaner/ Security Staff	CU Teaching Staff	Farmer	Total
CU	9(10.6%)	2(2.4%)	39(45.9%)	9(10.6%)	5(5.9%)	0(0%)	64(75.3%)
Tharaka	1(1.2%)	3(3.5%)	8(9.4%)	0(0%)	0(0%)	9(10.6%)	21(24.7%)
Total	10(11.8%)	5(5.9%)	47(55.3%)	9(10.6%)	5(5.9%)	9(10.6%)	85(100%)

3.2 Sensory Evaluation of the Products

3.2.1 Cake

The P10% cake was rated best in taste and second to the control in color and smell according to trained panelists. Consumer panelists, on the other hand, rated the P10% second to the control one in all characteristics. However, there were no significant differences in the likability level between most blending levels; Table 3 shows that only R20% had a significant difference ($P<0.05$) from the other blends for most characteristics (and R10% for color) according to the untrained panelists. The trained panelists similarly indicated significant differences ($P<0.05$) mostly between R20% and the rest of the levels. Results indicate that processing pigeon peas by precooking produces likeable products while roasting produces unacceptable qualities. The 10% pre-cooked pigeon pea/wheat flour composite results in characteristics that are much similar to those of all-wheat (control) cake thus generally acceptable to consumers.

Table 5 shows results from the FGD which indicate that the P10% cake tasted good and had the most appealing color that resulted from the flour blend while R20% was too dark and hence unappealing. Panelists further explained that R20% was fairly tough and tasted/smelt burnt.

3.2.2 Cookies

Table 4 shows that the 5% pre-cooked blend had high acceptability (untrained panelists) second to the control in all characteristics (except in smell where the 10% blend was the most acceptable); however, there was no significant difference between the acceptability of these two blending levels. There was no significant difference between the acceptability level of the 5% blend and the control in all the characteristics, hence these two levels compare well. Results from the trained panelists also showed no significant differences in likability of the different blending levels for color and texture while significant differences existed between R20% and the rest of the blending levels for taste, smell, general acceptability and intention to purchase.

However, according to the trained panelists, P10% was ranked second after the control in most characteristics; however, there were no significant differences.

The FGD results (Table 5) show that all-wheat cookies (control) were the most preferred in all characteristics. This means that blending cookies with pigeon pea flour does not significantly contribute to the likability of the product.

3.2.3 *Chapatti*

Results in Table 6 show that P5% and P10% blends were equally most preferred by trained panelists in color, texture and general acceptability. The same panelists most preferred P10% in smell and intention to purchase the product. Generally, *chapatti* made from precooked composite flour (P5% and P10%) was preferred compared with the control. Similar to cake and cookies, the R20% *chapatti* was the least

preferred in all characteristics. For both the trained panelists and the consumers, there were no significant differences between most of the characteristics for most blending levels, except with the R20%. From the results it is evident that *chapatti* prepared using P5%-P10% and R5%-R10% are more preferred compared to the control (except for color) and no significant difference exists between their characteristics.

From the Focus Group Discussion, it was clarified that the reason for the acceptability of the *chapatti* regarding color was that the one prepared using R20% was disliked most because it had an unpleasant (too dark) color. Table 5 indicates that the P10% was most liked, because of its presumed nice color and soft texture. On the contrary, the R20% was most disliked because of a too-dark color (deemed unpleasant).

Table 3. *Sensory evaluation results for cake prepared from wheat and pigeon pea (precooked and roasted) composite flours*

Trained Panelists (Food Science Teaching Staff at Chuka University)							Consumers (untrained panelists in Chuka and Tharaka sub-Counties)					
Blending Level	**Color***	**Texture**	**Taste**	**Smell**	**General Acceptability**	**Action Rating**	**Color**	**Texture**	**Taste**	**Smell**	**General Acceptability**	**Action Rating**
Control	4.80^{a}	4.20 ^{a}	3.60^{a}	4.20^{a}	4.20 ^{a}	3.80^{a}	4.34^{a}	4.26^{a}	4.20^{a}	4.16^{a}	4.25 ^{a}	4.09 ^{a}
P5%	3.00^{b}	3.60 ^{a}	3.80^{a}	3.80^{a}	3.60 ^{a}	3.40^{ab}	4.01^{a}	3.92^{ab}	3.89^{ab}	3.92^{ab}	3.97 ^{ac}	3.67 ^{ab}
P10%	4.20^{a}	3.80 ^{a}	4.00^{a}	4.00^{a}	3.60 ^{a}	3.20^{ab}	4.13^{a}	4.10^{ab}	4.07^{a}	4.05^{ac}	4.05 ^{a}	3.97 ^{a}
P20%	3.60 ^{a}	4.00 ^{a}	3.40^{a}	3.20^{a}	3.80 ^{a}	3.20^{ab}	3.74^{ab}	3.91^{ab}	3.89^{ab}	3.84^{ab}	3.85 ^{ac}	3.76 ^{ab}
R5%	3.60 ^{a}	3.80 ^{a}	3.20^{a}	2.60^{a}	3.20 ^{a}	2.80^{ab}	3.68^{ab}	3.81^{ab}	3.73^{ab}	3.60^{bc}	3.65 ^{bc}	3.64 ^{ab}
R10%	3.40 ^{a}	2.80 ^{a}	3.00^{a}	3.00^{ab}	3.00 ^{a}	3.00^{ab}	3.72^{b}	3.78^{ab}	3.81^{ab}	3.77^{ab}	3.64 ^{bc}	3.61 ^{ab}
R20%	2.60^{b}	3.00 ^{a}	2.20^{a}	2.20^{b}	2.20 ^{b}	1.80^{b}	3.51^{b}	3.63^{b}	3.42^{b}	3.44^{b}	3.51 ^{bc}	3.28 ^{b}
P-value	**0.005**	**0.166**	**0.073**	**0.007**	**0.007**	**0.96**	**0.000**	**0.004**	**0.000**	**0.000**	**0.000**	**0.000**

**Means followed by the same parameter within a column are not significantly different from each other at P=0.05 using LSD derived from the Tukey HSD test. P means a composite of wheat and precooked pigeon pea flour, and R means a composite of wheat and roasted pigeon pea flour. Data are based on a 5-point hedonic scale (1=dislike very much, 5=like very much).*

Table 4. *Sensory evaluation test results for cookies prepared from wheat and pigeon pea (precooked and roasted) composite flours*

Trained Panelists (Food Science Teaching Staff)							Consumers (untrained panelists in Chuka and Tharaka sub-Counties)					
Blending Level	**Color***	**Texture**	**Taste**	**Smell**	**General Acceptability**	**Action Rating**	**Color**	**Texture**	**Taste**	**Smell**	**General Acceptability**	**Action Rating**
Control	4.20^{a}	4.40^{a}	4.20^{a}	4.20^{a}	4.20^{a}	3.40^{ab}	4.55 ^{a}	4.45 ^{a}	4.40 ^{a}	4.42 ^{a}	4.38 ^{a}	4.35 ^{a}
P5%	3.20^{a}	3.00^{a}	3.20^{ab}	3.40^{a}	3.20^{ab}	2.80^{ab}	4.22 ^{ab}	4.07 ^{ac}	4.16 ^{ad}	4.14 ^{acd}	4.14 ^{ac}	4.10 ^{ac}
P10%	3.60^{a}	4.20^{a}	3.60^{ab}	4.00^{a}	3.80^{a}	3.60^{a}	4.06 ^{b}	3.98 ^{ac}	4.01 ^{ad}	4.15 ^{ac}	3.92 ^{ac}	3.95 ^{ac}
P20%	3.00^{a}	3.60^{a}	3.60^{ab}	3.60^{a}	3.60^{a}	3.40^{ab}	4.15 ^{ab}	3.97 ^{bc}	4.02 ^{ac}	4.02 ^{ac}	3.93 ^{ac}	3.93 ^{ac}
R5%	3.20^{a}	3.20^{a}	3.20^{ab}	2.80^{ab}	2.80^{ab}	2.80^{ab}	3.85 ^{bc}	3.85 ^{bc}	3.72 ^{bcd}	3.84 ^{bc}	3.66 ^{bc}	3.74 ^{ac}
R10%	3.60^{a}	2.80^{a}	3.00^{ab}	2.80^{ab}	2.60^{ab}	2.60^{ab}	3.98 ^{b}	3.63 ^{bc}	3.63 ^{bc}	3.66 ^{bcd}	3.78 ^{bc}	3.70 ^{bc}
R20%	2.40^{a}	3.40^{a}	2.20^{b}	1.60^{b}	1.60^{b}	1.60^{b}	3.48 ^{c}	3.52 ^{bc}	3.35 ^{b}	3.44 ^{b}	3.40 ^{b}	3.22 ^{b}
P-value	**0.220**	**0.030**	**0.085**	**0.004**	**0.004**	**0.043**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

*Means followed by the same parameter within a column are not significantly different from each other at *P*=0.05 using LSD derived from the Tukey HSD test. P means a composite of wheat and precooked pigeon pea flour, and R means a composite of wheat and roasted pigeon pea flour. Data are based on a 5-point hedonic scale (1=dislike very much, 5=like very much).

Table 5. *Focus Group Discussion Results*

Product	Characteristic	Liked very much/Reason	Disliked very much/Reason
Cake	Taste	P10%- tastes good	R20%- tastes burnt
	Color	P10%- has a nice color from the flour blend	R20%- too dark unpleasant color
	Texture	P20%- it is nice and soft	R20%- feels tough
	Smell	Control- has a nice smell compared with the rest	R20%- burnt smell
	General Acceptability	P10%- because it has a generally pleasant color & taste	R20%- all its characteristics are not pleasing compared to the rest
	Action Rating	P10%- we would buy this more for a change from all wheat cakes	R20%- is not appealing at all

Cookies	Taste	Control- tastes best of all the products	R20%- has a very bad taste
	Color	Control- appears the best as it has bright color, not dark like some	R20%- looks too dark hence not appealing
	Texture	Control- it is not as tough as the majority of the other products	R20%- quite tough when eating
	Smell	Control- has a pleasant smell compared to some of the others	R20%- smells burnt
	General Acceptability	Control- generally most likeable in taste, color & texture	P20- it just doesn't good, too dull
	Action Rating	Control- has the most likable qualities	P20%- the color is not pleasing
Chapatti	Taste	P20%- the added ingredients give it a pleasant taste	R20%- has a burnt taste
	Color	P10%- appealing color compared with the rest	R20%- unpleasant color (too dark)
	Texture	P10%- very nice soft texture	R20%- a bit tough
	Smell	P10&- it also smells nice	R20%- an unpleasant burnt smell
	General Acceptability	P10%- has the best taste of all the products, also considering that other qualities are appealing	R20%- generally its color is very unpleasant and thus not attractive
	Action Rating	P20%- it has the best taste of all	20%- has a really bad taste

4. Discussion

This study included respondents from a wide representation from the communities, including both gender, varying ages (excluding extremely young and old individuals) and occupations. Both too-young and too-old individuals are excluded from such a sensory evaluation because of their different sensory judgments. Sensory perception, according to (Linford et al, 2010), reduces with age, while sensory evaluation among children makes use of a different tool (Guinard, 2000). At the same time, the inclusion of an expert panel minimizes the effect of cultural, psychological, religious, social, educational status and nutritional knowledge that may influence the interpretation of sensory qualities among consumers (Jain & Gupta, 2005).

Evaluation of the products revealed that those prepared using precooked pigeon pea flour in the flour blend were the most preferred, whereby P10% cake was most preferred and R20% most disliked, with FGD revealing a dislike of taste/flavor. A study by Fasoyiro et al. (2010) in their study assessing the sensory properties of two Nigerian traditional foods, *Akara* and *Moinmoin* made using flours prepared by either soaking, blanching or roasting pigeon peas similarly indicated that products made using flours from the roasted pigeon pea varieties were the least accepted in terms of appearance color, flavor and overall acceptability.

Evaluation of cookies indicated similarity in acceptability level of 0% (control), P5% and P10%, with trained panelists rating 0% and P10% the same, and consumers rating P5% second after the control. This seems to indicate that blending the wheat flour with between 5% and 10% pre-cooked pigeon pea flour would probably produce acceptable products for the market. However, the 5% level rated second after the control by consumer panelists is way below the 10% minimum level envisaged by Kenya's flour blending initiative aiming at increasing the demand and consumption of underutilized high-nutrition crops (Conti et al., 2021).

Upon evaluating chapatti, the respondents similarly indicated that the roasted pigeon flour (20%) composite resulted to too dark, unpleasant color, while precooked one resulted to a nice color. A study on varying substitution levels of wheat flour with pigeon pea flour by Sachanarula et al. (2022) reported an increase in lightness and yellowness of *chapattis* made from wheat-pigeon pea flour blends. In another study (Wani et al, 2016), *chapatti* prepared from wheat-pulse composite flour showed a significant decrease in color, taste and aroma as well as overall acceptability. Results from the current study indicate that blending 5-10% of either pre-cooked or roasted pigeon pea flour into wheat flour contributes positively to the consumer acceptability of *chapatti*.

Table 6. *Sensory evaluation test results for chapatti prepared from wheat and pigeon pea (precooked and roasted) composite flours*

Trained Panelists (Food Science Teaching Staff)							Consumers (untrained panelists in Chuka and Tharaka sub-Counties)					
Blending level	**Color***	**Texture**	**Taste**	**Smell**	**General Acceptability**	**Action Rating**	**Color**	**Texture**	**Taste**	**Smell**	**General Acceptability**	**Action Rating**
Control	4.40^{a}	2.40^{a}	3.00^{abc}	3.00^{a}	3.00^{a}	2.40^{a}	4.50^{a}	3.77^{ac}	3.49^{a}	3.87^{a}	3.74^{a}	3.66^{ac}
P5%	3.60^{a}	3.80^{ab}	3.60^{b}	3.20^{a}	3.40^{a}	3.00^{a}	3.93^{b}	3.95^{a}	3.76^{a}	3.71^{a}	3.72^{a}	3.68^{ac}
P10%	3.60^{a}	3.80^{ab}	3.40^{abc}	3.60^{a}	3.40^{a}	3.40^{a}	3.82^{b}	3.89^{a}	3.70^{a}	3.90^{a}	3.89^{a}	3.70^{ac}
P20%	3.60^{a}	3.40^{a}	3.60^{ab}	3.40^{a}	3.00^{a}	2.80^{a}	3.76^{b}	3.85^{a}	3.74^{a}	3.75^{a}	3.68^{a}	3.78^{c}
R5%	4.00^{a}	3.40^{a}	3.60^{a}	3.40^{a}	3.00^{a}	3.20^{a}	3.97^{b}	3.56^{abc}	3.35^{ab}	3.43^{ab}	3.43^{ab}	3.30^{bc}
R10%	3.60^{a}	3.20^{a}	3.00^{ac}	3.20^{a}	3.20^{a}	2.00^{a}	3.52^{b}	3.32^{bc}	3.20^{ab}	3.45^{ab}	3.26^{ab}	3.18^{ab}
R20%	1.20^{b}	1.60^{a}	1.60^{c}	1.60^{a}	1.60^{a}	1.40^{a}	2.86^{c}	3.24^{bc}	2.92^{b}	2.97^{b}	3.07^{b}	2.90^{b}
P-value	**0.000**	**0.013**	**0.030**	**0.109**	**0.073**	**0.133**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

**Means followed by the same parameter within a column are not significantly different from each other at P=0.05 using LSD derived from the Tukey HSD test. P means a composite of wheat and precooked pigeon pea flour, and R means a composite of wheat and roasted pigeon pea flour. Data are based on a 5-point hedonic scale (1=dislike very much, 5=like very much).*

5. Conclusions and Recommendations

From the results of this study, it was concluded that pigeon peas processed by precooking provide acceptable base flour for wheat products. The taste of P10% cake was rated best by trained panelists while consumer panelists rated the same second after the control in all characteristics, however, there were no significant differences. Focus group discussion results revealed P10% as the most preferred, with the most appealing color and best taste between the treatments. The P20% level, on the other hand, was rated worst in all characteristics, with the FGD indicating several negative attributes including a burnt taste and smell, and too dark color among other unappealing characteristics. The P10% cookies were ranked second after the control in most of the characteristics (by trained panelists) though no significant difference between the likability of the two levels. A check through the FGD showed that the control cookies were the most preferred in all characteristics. *Chapatti* made from P5%, P10%, R5% and R10% all scored better than the control in all characteristics except color (trained panelists), but no significant differences existed. The FGD indicated P10% *chapatti* as the most preferred due to its nice pleasant color and soft texture.

This study, therefore, recommends the adoption of P10% cake and P5% cookies into the market. Further, owing to the positive nutritional benefits of pigeon peas, household consumption of P10% *chapatti* should be promoted among community members. This would promote the consumption of nutrient-rich snack products made from wheat, compared to the high-fat, high-sugar and low-fibre snacks available in the market. The study recommends further research to determine the nutrient content of products made from these products, the effect of processing on anti-nutrient levels as well as carrying out studies on the shelf life and cost-benefit analyses before rolling out the products into the market.

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