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EVALUATION OF SENSORY ACCEPTABILITY OF BAKERY PRODUCTS PREPARED FROM BLENDED WHEAT AND PUMPKIN COMPOSITE FLOUR

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ABSTRACT
The pumpkin fruit of the species *C. moschata* Duchesne has great nutritional potential, but remains under-utilized in Kenya. The fruits have diverse health enhancing properties. This vegetable-fruit has potential to be processed into various products both for home and industrial use. Despite these benefits, the fruit is underutilized as characterized by the few available pumpkin fruit flour products' recipes and little contribution to food security in Kenyan households. The present study determined sensory acceptability of baked products of blended pumpkin and wheat composite flour. Uniform mature pumpkin fruits grown on the Chuka University farm were harvested and processed into flour using a previously developed protocol. Pumpkin flour was augmented at 0%, 5%, 20%, 50% and 95% into wheat flour and baked to make cake, bread, mandazi, scones and cookies. The products were then subjected to sensory acceptability tests using a 5-scale hedonic rating, with 1 being least preferred and 5 most preferred by trained and untrained panelists at KALRO-Njoro and consumer groups in Nyeri County, Kenya. The ANOVA showed that products significantly (P<0.05) differed in acceptability. Among Nyeri consumers, 50% cake and 5% mandazi and scone formulations were highly preferred for colour, texture and flavour. In Njoro, there were significant differences (P<0.05) among the trained and untrained panelists, but overall in all products, the 0% and 5% formulations scored highest across all test parameters. Value addition and commercial utilization of any food product greatly increases demand. This study shows the great potential of value-added pumpkin flour in enhancing and enriching textural and sensory qualities of different commercial food products in the Kenyan food industry, which should be promoted for adoption and commercialization.

KEYWORDS: African Indigenous vegetables, Food security, Fruit-vegetable, Organoleptic taste, Value addition.

INTRODUCTION

Pumpkin belongs to the genus *Cucurbita* of the family *Cucurbitaceae*. Pumpkins are a native of Central America but have been domesticated in several tropical and sub-tropical countries around the world (Juna *et al*., 2006). The varieties of pumpkin grown widely in Kenya are of the species *C. moschata* and *C. maxima* (squash pumpkin), of which *C. moschata* remains locally naturalized and widespread in the high potential areas as well as the arid and semi-arid lands (ASALs). Pumpkin is high in β-carotene, which gives it yellow or orange colour. It is also high in carbohydrates and minerals. Beta-carotene in plants that have a pleasant yellow-orange colour is a major source of vitamin A (Lee, 1983). Consumption of foods containing carotene helps prevent skin diseases, eye disorders and cancer (Bendich, 1989). Incorporation of β-carotene-rich materials in the human diet is considered a cost-effective approach to managing health problems related to vitamin-A deficiency (Berteram and Bortkiewicz, 1995). Pumpkins supply calcium, iron, 25% to 55% oil rich in unsaturated oleic and linoleic acids, 25% to 35% protein with high amounts of arginine, aspartate and glutamic acid, although it is deficient in lysine, and sulphur-containing amino acids (Usha *et al*., 2010). Pumpkin has high nutritional potential that is equal to no other single crop (Encyclopedia of Foods, 2004). Pumpkins are widely used in most African countries for their food value. The cooked mature fruit of pumpkins is the preferred food product. It is also popular for making pie. In South-East Asia, it is made into sweets and desserts, of steamed fruit flesh with grated coconut and sugar, and into crisps made by frying steamed fruit flesh mixed with cassava flour. In Zambia, the ripe fruit flesh is dried for longer preservation (Mnzava and Mbewe, 1997). Commercially, in China, India and USA, pumpkin is canned. In Nigeria, pumpkin leaves are used to make soup, cassava salad, plantain porridge and '*Asaro* or *Ebe'* (yam pottage). *M'chicha Wa Nazi*, common in Tanzania, is a soup made by blending pumpkin leaves, peanut butter, onion, chili and coconut. Traditionally, pumpkin has not been regarded as a delicacy by many households in Kenya. It is 'a forgotten super food', whose fruits are only consumed due to lack of potatoes, while leaves are used in absence of cabbages or kales. Sometimes, the fruit is blended in *mukimo*, a main meal prepared by mixing cooked maize and peeled potatoes with pumpkin leaves (Arimi Foods, 2011).

Traditional food crops face poor consumption especially in urban and cosmopolitan centers where dwellers tend to purchase processed and packaged food for convenience (Onyango *et al*., 2008). It has been reported that per capita consumption of fruits and vegetables in sub-Saharan Africa lags behind that of other regions (Shiundu and Oniang'o, 2007). Dietary diversification is a long term

strategy which plays an important role in preventing micronutrient malnutrition by increasing the availability and consumption of different varieties of micronutrient-rich foods. Dietary diversity can be achieved through increased production and consumption of micronutrient-rich foods as well as better food preparation methods (MOH/UNICEF, 2004). Incorporation of β-carotene rich materials in human diet is considered a cost-effective solution to vitamin-A deficiency related health problems (Berteram and Bortkiewicz, 1995).

Wheat has been used worldwide in a variety of food products and confectionaries (Lee *et al*., 2002 and Pongjanta *et al*., 2006]. Currently, wheat bakery and confectionary products are fortified with various vitamins and minerals nutrients to enrich them to become a complete food. Wheat flour contains a limited amount of important nutrients like zinc, iron and important phytochemicals including beta-carotene, which are available in variety of fruit and vegetable products (Tee *et al*., 1991 and Olson, 1989) such as pumpkin powder for blending. Development of food products with attractive colour has been a major goal in the food industry (El-Demery, 2011) and pumpkin flour is popular due to its highly-desirable flavour, sweetness, deep yellow-orange colour and considerable amount of dietary fiber. It is reportedly used to supplement cereal flours in bakery including soups, sauces, instant noodle and spices, and as a natural colouring agent in pasta and flour mixes (Djutin, 1991). The objective of the present study was to investigate acceptability of various bakery products made from blended wheat and pumpkin flours.

MATERIALS & METHODS

Pumpkin Flour and Products Preparation

Mature pumpkin fruits of one landrace (*C. moschata*) that had previously been grown on the Chuka University Experimental Farm were washed, peeled and cut uniformly into 2.5cm by 0.5cm by 0.5cm slices. The slices were blanched in 98^{o}C boiling water for 1 minute and dried in an enclosed solar cabinet until brittleness was achieved (Wokneh *et al*., 2012). Dried slices were then milled into flour and utilized in blending products (Kiharason *et al*., 2016, in Press).

Formulations of Pumpkin-Blended Products

Five types of bakery products; namely: cake, cookies, scones, bread and *mandazi* were prepared using five levels of pumpkin flour to substitute wheat flour in the formula of each product at 0%, 5%, 20%, 50% and 95% (tables = 80%) rate. The five levels of the products were subjected to organoleptic test by trained and untrained panelists in KALRO-Njoro, as well as consumer groups in Nyeri County of Kenya. The amount of pumpkin and wheat flour was varied in each recipe, while holding all other ingredients constant. All products were arranged and tested in Completely Randomized Design.

Wheat and pumpkin flour blended cake

The ingredients were 200 g (50%) all-purpose wheat flour, 200 g (50%) pumpkin flour, 200 g margarine, 200 g sugar, 10 g baking powder and 3eggs. The flours and baking powder were sifted, margarine 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^{o}C for 35 minutes until the cake developed a distinct scent and golden brown crust.

Wheat and pumpkin flour blended cookies

The ingredients were 200 g (50%) all-purpose flour, 200 g (50%) pumpkin flour, 160 g butter at room temperature, 40 g shortening, 2 eggs at room temperature, 200 g sugar and ½ teaspoon salt. The butter and shortening were mixed together using a wooden spoon until uniform. Sugar was added and mixed until ingredients were light and fluffy. Eggs were added and the mixture stirred until ingredients were well combined. The flour, baking powder and salt were whisked together in a separate bowl and ⅓ of the dry ingredients added to the bowl of wet ingredients and stirred until they were just combined. Dry ingredients were gradually added continuously while stirring. The oven was pre-heated to 205°C and a baking sheet lined with parchment paper. The dough was scooped out using a tablespoon and shaped into balls using clean hands. Each ball of dough was placed onto the baking sheet, leaving about 5 cm of space all around for spreading as it cooked. The cookies were baked for up to 10 minutes, removed from the oven, cooled for 2 minutes, loosened using a spatula and placed on wire racks to cool down.

Wheat and pumpkin flour blended scones

The ingredients were from 200 g (50%) all-purpose flour, 200 g (50%) pumpkin flour, 30 g fat, 125 ml milk, 12.5 g baking powder, and 2.5 g salt. The flour was sifted with other dry ingredients into a large mixing bowl and rubbed in fat while aerating at the same time. A deep well was made in the flour where almost all liquid ingredients were poured and mixed to soft dough with a palette knife. The remaining liquid ingredients were added. On a floured surface, dough was kneaded very lightly until it was just smooth and divided into two pieces that were each lightly shaped into a ball. Each piece was then flattened to 2 cm thickness and cut into 6 triangles. The oven was pre-heated and scones brushed with beaten eggs for a glossy crust. Scones were left to rest for 10 to 15 minutes before baking at 245^{o}C at the top oven, until well risen and brown.

Wheat and pumpkin flour blended mandazi

The ingredients were 200 g (50%) wheat flour, 200 g (50%) pumpkin flour, 100g margarine, 100g sugar, 500 ml cooking oil, 3 eggs, 2 teaspoons baking powder and 125 ml milk. All ingredients were mixed by combining dry ingredients well, then adding the beaten eggs and milk. The dough was left to stand for about 15 minutes to rise. Meanwhile, oil was heated in a deep frying pan. Dough was rolled over a lightly floured surface into 0.625 cm thickness, cut into desired size and shape, deep-fried until golden brown and then drained on paper towels.

Wheat and pumpkin flour blended bread

The ingredients were 200 g (50%) strong flour, 200 g (50%) pumpkin flour, 12 g vegetable fat, 240 ml water, 16 g fresh yeast, 16 g sugar and 8 g salt. Baking tins were lightly greased. Flour and salt were shifted into a large bowl. Fat was added and rubbed into flour using finger tips. One-third of water was boiled and added to the remaining cold water to make it warm. Fresh yeast and sugar were put into a basin and mixed with the liquid. A deep hole was made in the flour and the liquid mixture

added and mixed thoroughly using hands with a clawing movement for 3 minutes until the dough freely peeled off fingers. Dough was turned onto lightly floured surface and kneaded for 10 minutes until smooth and elastic. Dough was shaped, covered with greased heat-proof polythene and left to rise for 45 minutes. Dough surface was then dusted with flour and baked in a hot oven at 245^{o}C until golden brown.

Sensory Evaluation

The products were cooled and packed in clear polythene bags and kept at room temperature awaiting sensory evaluation the following day. Each of the products was then cut into 3-cm x 1-cm x 1-cm-pieces. The consumer likability test was carried out in Nyeri County of Kenya among 25 consumers for each of the five products. All the panelists were screened before included to eliminate personal prejudice thus ensure objective evaluation ad description of product characteristics (Singh-Ackbarali and Maharaj, 2014). Criteria included state of health thus avoiding ill individuals, age i.e. excluding too young and too old as their tasting, visual and judgment abilities may be extreme. Women's physiological status was put into consideration to avoid those who were expectant due to altered taste perceptions. The rating was done on a 5-point hedonic scale with 5 indicating like extremely to 1 indicating dislike extremely (Watts *et al*., 1989). Samples were served on white plates and water was provided to rinse the mouth between samples. In addition, Focus Group Discussions were done to obtain qualitative data among different sets of consumers selected following the same criteria described earlier for best results. The qualitative data were meant to corroborate the quantitative data and provide explanations on reasons of like or dislike of a particular blended product. The evaluation of the five products was staggered over several days to avoid consumers being exhausted during tests and for data quality control. In addition, panels of 6 food experts at KALRO-Njoro Food and Nutrition laboratories were involved in tests on the same set of products so as to determine if the blended products possessed the generally acceptable characteristics of each specific product. Another 25 untrained panelists in the same place were involved in the tests to remove the likely bias with trained panelists.

Statistical Analysis

Data were subjected to analysis of variance (ANOVA) using SAS version 9.3 and significantly different means were separated using Least Significance Difference at α = 0.05.

RESULTS

Sensory evaluation for cake in Nyeri showed that level 1 was ranked best in terms of taste, flavour and texture, while level 3 was rated best for colour (Table 1). Level 5 was ranked least liked for taste, flavour, colour and texture hence generally least liked by the consumers. Levels 1, 2 and 3 were generally liked, with no significant difference in taste and texture among all the three products, while results also showed no significant difference in colour of levels 1 and 2.

Evaluation of *mandazi* among the study consumers showed significant differences (P<0.05) for all test parameters in all the five levels. Table 4 below shows that level 2 was ranked best in all test parameters hence most liked, followed by level 3 for taste, flavour and colour. Therefore, addition of pumpkin flour had significant effect on each test parameter. Level 5 was ranked least in taste, flavour, colour and texture, thus it was least liked.

Trained panelists in Njoro laboratories, rated level 1 *mandazi* products best in all test parameters, while among untrained panelists, levels 1 and 2 were equally liked in taste, flavour and colour. Levels 1 and 2 had no significant differences in all test parameters (Table 4). Levels 4 and 5 were clearly disliked in all aspects by both groups.

Evaluation of bread among the study consumers showed significant differences (P<0.001) for all test parameters in all the five levels. Level 2 was ranked superior in all parameters, while level 1 was also preferred in taste, flavor and texture. Table 5 also shows that level 3 was also liked in taste. It is notable that level 5 was least preferred for all test parameters.

Levels 1 and 2 of bread ranked high in all organoleptic parameters for both trained and untrained panelists in Njoro (Table 5). Level 5 ranked least liked for taste, flavour, colour, texture and acceptability. There were no significant differences (P>0.05) in the taste, flavour and colour of levels 1 and 2 of bread among both groups. Texture was affected significantly up to level 5, which was least liked by both groups.

DISCUSSION

Addition of 5% and 20% of pumpkin flour into cake recipes introduced desirable characteristics. As much as study consumers rated level 1 as best liked generally, level 3 according to them proved to be the best in appearance. Focus groups discussions indicated that levels 2 and 3 of cake were best in colour due to the nice orange colour introduced by the pumpkin flour. Level 5 was rated worst in all aspects because the colour was too dark, which is unpleasant and that the texture was too soggy for a cake. It caused a bitter flavour and too much unpleasant pungent pumpkin taste. Substitution of pumpkin flour caused the pungent flavour due to presence of cucurbitacins in the pumpkin fruit which are extremely bitter with a disagreeable taste (Gry *et al*., 2006). The darkening could be attributed to caramelization and maillard reactions where the protein contributed by pumpkin flour reacted with sugar during baking (Dhingra and Jood, 2001 and Mohsen *et al.*, 2009). Sogginess of 95% cake is indication that the product had too much moisture in it, and the level of moisture in a product correlates with the fibre content. PF as reported by Pratyush *et al*. (2015) contains high amounts of fibre (hence much retention of water in the finished product). Similarly, See *et al*. (2007) in their study reported that an increase in the level of pumpkin flour increased the moisture content of breads, explaining that composite flours which result to increased fibre have a higher water absorption capacity as compared to wheat flour.

TABLE 1: Organoleptic test results in Nyeri and Njoro for cake made from wheat and pumpkin composite flour

Level	Nyeri consumers				Njoro untrained panelists (consumers)					Njoro trained panelists				
(% PF)	Taste *	Flavour	Colour	Texture	Taste	Flavour	Colour	Texture	General	Taste	Flavour	Colour	Texture	General
1 (0%)	4.16 a	4.20a	3.48b	4.08a	3.75a	4.00a	3.67bc	3.83a	3.83a	3.27a	3.27a	3.86a	3.64a	3.64a
2 (5%)	3.88 a	3.80b	3.76b	4.00 a	4.33a	4.25a	4.42a	4.17a	4.25a	3.09a	3.41a	3.36a	2.86b	3.41a
3 (20%)	4.12a	3.96 ab	4.08a	3.96 a	3.75a	4.00a	3.92ab	3.79a	4.00a	2.27b	2.77b	2.68b	2.45bc	2.32b
4 (50%)	2.96 b	2.76 c	2.40 c	3.12b	3.04b	3.21b	3.04c	2.88b	2.71b	1.55c	2.32c	2.18bc	2.18cd	1.82bc
5 (95%)	2.20 c	2.24 d	1.68 d	2.40 c	2.17c	2.33c	2.13d	2.25b	2.00c	1.18c	1.77d	1.95c	1.73d	1.64c
$LSD_{0.05}$	0.6841	0.5885	0.6672	0. 6525	0.6841	0.5885	0.6672	0.6525	0.646	0.5195	0.4526	0.6302	0.5857	0.5821
P-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

*Means followed by the same letter within a column are not significantly different from each other at *P*=0.05. PF = pumpkin flour.

TABLE 2: Organoleptic test results in Nyeri and Njoro for cookies made from wheat and pumpkin composite flour

	Nyeri consumers				Njoro untrained panelists (consumers)					Njoro trained panelists				
Level (% PF)	Taste *	Flavour	Colour	Texture	Taste	Flavour	Colour	Texture	General	Taste	Flavour	Colour	Texture	General
1 (0%)	3.75a	3.83 a	3.33 b	3.67 b	3.92a	3.76ab	3.14a	3.84a	4.04ab	4.30a	4.30a	4.20a	4.40a	4.20a
2 (5%)	4.00 a	3.83 a	3.79 a	4.04 a	3.92a	3.92a	3.14a	3.96a	4.28a	4.00a	4.10a	4.10a	3.70ab	3.80a
3 (20%)	3.71a	3.96 a	3.71 a	3.54 b	3.40ab	3.20bc	3.14a	3.64a	3.68b	3.10b	3.20b	2.60b	3.40bc	3.00b
4 (50%)	3.21 b	3.21 b	3.33 b	2.83 c	3.08b	2.80c	3.14a	3.00b	3.04c	2.80bc	2.50bc	3.00b	3.10bc	2.60bc
5 (95%)	2.00 c	2.00 c	1.42 c	2.25 d	2.44c	1.96d	3.14a	1.84c	1.92d	2.10c	2.10c	2.10b	2.80c	2.00c
$LSD_{0.05}$	0.5546	0.6534	5.6352	0.6165	0.5546	0.6534	5.6352	0.6165	0.5923	0.7772	0.8056	0.9087	0.776	0.7783
P-value	<.0001	<.0001	1.0000	<.0001	<.0001	<.0001	1.000	<.0001	<.0001	<.0001	<.0001	<.0001	0.0018	<.0001

*Means followed by the same letter within a column are not significantly different from each other at *P*=0.05. PF = pumpkin flour.

TABLE 3: Organoleptic test results in Nyeri and Njoro for scones made from wheat and pumpkin composite flour

Level	Nyeri consumers				Njoro untrained panelists (consumers)					Njoro trained panelists				
(% PF)	Taste *	Flavour	Colour	Texture	Taste	Flavour	Colour	Texture	General	Taste	Flavour	Colour	Texture	General
1 (0%)	3.65 a	3.65 a	3.19 bc	3.46 bc	3.90a	3.86a	4.14a	4.14a	4.10a	3.75a	3.75a	4.00a	3.83a	4.08a
2 (5%)	3.69 a	3.65 a	3.85 a	3.81 a	3.67a	3.76a	3.62b	3.71a	3.95a	3.50a	3.67a	4.00a	3.75a	3.75ab
3 (20%)	3.50 a	3.27 b	3.42 b	3.62 ab	2.90b	3.14b	2.71bc	2.90b	3.05b	3.17a	3.25a	2.58b	3.33a	3.17b
4 (50%)	2.88 b	2.62 c	2.88 c	3.19 c	2.10c	2.52c	2.81b	2.24c	2.33c	2.25b	2.33b	2.42b	2.58b	2.50c
5 (95%)	1.96 c	1.88 d	1.92 d	2.42 d	1.76c	2.29c	2.10c	1.90c	1.71d	1.50c	1.92b	1.83b	1.83c	1.67d
$LSD_{0.05}$	0.6241	0.4761	0.695	0.5687	0.6241	0.4761	0.695	0.5687	0.57	0.7164	0.8012	0.8791	0.6542	0.6655
P-value	<.0001	<.0001	1.0000	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	1.0000	<.0001	<.0001	<.0001

*Means followed by the same letter within a column are not significantly different from each other at *P*=0.05. PF = pumpkin flour.

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TABLE 4: Organoleptic test results in Nyeri and Njoro for *mandazi* made from wheat and pumpkin composite flour

Level (% PF)	Nyeri consumers				Njoro untrained panelists (consumers)					Njoro trained panelists				
	Taste *	Flavour	Colour	Texture	Taste	Flavour	Colour	Texture	General	Taste	Flavour	Colour	Texture	General
1 (0%)	3.50bc	3.50b	3.42 c	3.50b	3.62a	3.81a	4.05a	4.00a	4.10a	3.92a	4.08a	4.75a	4.33a	4.42a
2 (5%)	3.96a	4.25 a	4.38 a	3.92a	3.62a	3.81a	4.10a	3.81a	3.67a	3.67a	3.58ab	4.17b	3.83ab	3.67b
3 (20%)	3.71ab	3.54b	3.83b	3.38b	2.81b	3.10b	2.71b	2.95b	2.90b	3.33a	3.25b	2.50c	3.33b	3.25b
4 (50%)	3.21c	2.71c	3.04d	2.83c	1.71c	2.29c	1.62c	2.43bc	1.95c	2.17b	2.25c	1.50d	2.25c	2.08c
5 (95%)	2.42d	2.08d	2.42e	2.54c	2.00c	2.33c	2.24b	2.29c	2.00c	1.58b	2.08c	1.42d	1.58c	1.50c
$LSD_{0.05}$	0.6043	0.4712	0.5605	0.6526	0.6043	0.4712	0.5605	0.6526	0.5095	0.8019	0.7742	0.5035	0.7164	0.6409
P-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

*Means followed by the same letter within a column are not significantly different from each other at *P*=0.05. PF = pumpkin flour.

TABLE 5: Organoleptic test results in Nyeri and Njoro for bread made from wheat and pumpkin composite flour

Level (% PF)	Nyeri consumers				Njoro untrained panelists (consumers)					Njoro trained panelists				
	Taste	Flavour	Colour	Texture	Taste	Flavour	Colour	Texture	General	Taste	Flavour	Colour	Texture	General
1 (0%)	3.58a	3.70a	3.62ab	3.54a	3.27a	3.27a	3.86a	3.64a	3.64a	3.08a	3.25a	3.67a	3.58a	3.50a
2 (5%)	3.62a	3.75a	3.95a	3.79a	3.09a	3.41a	3.36a	2.86b	3.41a	2.83a	3.08a	3.17a	2.83ab	2.92ab
3 (20%)	3.50a	3.20b	3.45b	3.45ab	2.27b	2.77b	2.68b	2.45bc	2.32b	2.50ab	2.67ab	2.92a	2.83ab	2.75ab
4 (50%)	2.79b	2.50c	2.79c	3.12b	1.55c	2.32c	2.18ab	2.18cd	1.82bc	2.00bc	2.08b	1.92b	2.08bc	2.25b
5 (95%)	1.79c	1.70d	1.83d	2.70c	1.18c	1.77d	1.95c	1.73d	1.64c	1.42c	1.83b	1.33b	1.67c	1.42c
$LSD_{0.05}$	0.5195	0.4526	0.6302	0.5857	0.5195	0.4526	0.6302	0.5857	0.5821	0.7993	0.8432	0.8317	0.7788	0.759
P-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0007	0.0044	<.0001	<.0001	<.0001

*Means followed by the same letter within a column are not significantly different from each other at *P*=0.05. PF = pumpkin flour.

The results are similar to the trained and untrained panelists, who seemed to agree that addition of 5% and 20% pumpkin flour into the recipes produced desirable effects, while addition of too much pumpkin flour spoiled the products. A similar study by Pongjanta *et al*. (2006) showed that 20% pumpkin flour addition to wheat flour was optimum for cakes, while 10% to 20% pumpkin powder in Thai desserts improved yellow colour, β-carotene content and was accepted by consumers. Considering cookies, the first three levels were comparable in terms of taste and flavour, with addition of 5% pumpkin flour producing best results in taste, texture and colour. As pumpkin flour increased, however, the likability level decreased. This was explained in the Focus Group Discussions that the colour of level 5 was too dark, that the crumb texture was too tough and left a bitter flavour in the mouth. Tough crumb texture has been associated with increased fibre due to substitution of refined wheat flour with pumpkin flour (Elimam *et al*., 2008). The level 2 of scones proved to have the most desirable characteristics among the study consumers, while both panel groups in Njoro appeared to dislike any pumpkin blended scones, rating level 1 as the best product and level 2 coming second. As pumpkin flour ratios increased, likability decreased greatly. The Focus Discussion Groups revealed that the dislike of level 5 was due to too dark colour that made scones appear burnt. A dark crust has been reported for whole wheat bread, fortified breads and biscuits and could be directly related to the increase in fibre content (Akhtar *et al*., 2008, Serrem *et al*., 2011 and Hu *et al*., 2007). The flavour was reported to have bitterness for level 5 and texture too tough compared to other levels, both attributed to presence of cucurbitacin and fibre.

For *mandazi* product, any addition of pumpkin flour had a significant effect on all test parameters. Level 2 of 5% pumpkin flour addition produced the best results, while level 5 of 95% pumpkin flour addition spoilt the product. Focus Discussion Groups explained that level 5 caused a bitter taste, darkening and closed texture. Bitter taste as explained earlier is associated with presence of cucurbitacins while darkening is attributed to high fibre content. In addition, a closed texture was clearly due to less gluten in recipes with more pumpkin flour. More pumpkin flour in the recipe causes less gluten level hence loss of the cohesive property and plasticity of the dough (Sigh et al., 2013). It is also due to increased fibre content; dietary fibre has been reported to have pronounced effects on dough properties and smaller extensibility (Gomez *et al*., 2002 and Elleuch, *et al*., 2011).

Trained panelists most preferred bread was the control level 1 of 0% pumpkin flour and level 2 of 5% pumpkin flour came closely second. Similarly, the untrained panelists indicated highest liking of level 1 for taste, colour, texture and general acceptability, while their most preferred flavour was of level 2. It appears that for bread, only slight additions of pumpkin flour would produce desirable characteristics. Clearly the presence of more pumpkin flour in the formulations especially for bread affects dough structure and reduces bread volume due to addition of fibre. More substitution of wheat flour leads to dilution of gluten network thus impairing gas retention in bread making (Dewettinck *et al*., 2008, Eliman *et al*., 2008 and Elleuch *et al.,* 2011). Similarly in a study by El-Demery (2011), 5% to 10% wheat flour substitutions with pumpkin flour had highest scores for all quality attributes in toast bread. A study by See *et al*., 2007 also reported that adding 5% pumpkin flour into bread recipe resulted to a high loaf volume and good overall acceptability.

CONCLUSIONS AND RECOMMENDATIONS

This study shows that replacement of refined wheat flour with 5% to 20% pumpkin flour produces likeable organoleptic qualities in snacks and confectionaries of cake, cookies, scones, *mandazi* and bread. On the other hand, too much pumpkin flour leads to too much dislike of the products. It is concluded that level 3 (20% pumpkin flour substitution) of the cake formulation has a great chance of adoption into the market given that it leads to desirable sensory attributes compared to other blending levels. It is therefore recommended to roll out this product blend into the market and test its marketability so as to determine the possibility of adopting the same into Kenyan market of convenience foods. It is also concluded that level 2 of cookies have the most desirable attributes according to the consumer groups involved. This formulation should be tested in the Kenyan market to determine its acceptability as a snack food. For scones, *mandazi* and bread, level 2 is the best candidate for tests to determine their marketability. Pumpkin-wheat composite flour improves the texture, flavour, taste and colour of different bakery and food products and should be used as important ingredients in bakery products. This study shows the great potential of value addition to various commercial food products in the food industry by pumpkin flour to produce high textural and sensory qualities. Preparation and processing of the above-tested products that have good organoleptic characteristics due to pumpkin flour supplementation in wheat flour, followed by consumption, promotion and marketing alongside their rich nutrient base, is highly recommended.

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REFERENCES

Akhtar, S., Anjum, F., Rehman, S., Sheikh, M. and Farzena, K. (2008) Effect of fortification on the physico-chemical ad microbiological stability of wole wheat flour. *Fooghyd Chem.,* **112**, 156-163.

Arimi, J. (2011) Arimi foods: Pumpkin-a forgotten super food. http:// www.arimifoods.com. Accessed on 15th January, 2013.

Bendich, A. (1989) Carotenoids and the immune response. *J. Nutr.,* **119**, 112-115.

Berteram, J.S. and Bortkiewicz, H. (1995) Dietary carotenoid inhibit neoplastic transformation and modulate

gene expression in mouse and human cell. *Am. J. Clin. Nutr.*, **62**, 132S-136S.

Dewettinck, K., Van Bockstaele, F., Kuhne, B., Van de Walle, Courtens, T. and Gellynck, X. (2008) Nutritional value of bread: Influence of processing, food interaction and consumer perception. *Rev. J. Cereal Sci.*, **48**, 243-257.

Dhingra, S. and Jood, S. (2002) Physio-chemical and nutritional properties of cereal-pulse blends for bread making. *Nutritional Health* **16** (3), 183-94.

Djutin, K.E. (1991) Pumpkin: Nutritional properties. *Potatoes and Vegetables* **3**, 25-26.

El-Demery, M.E. (2011) Evaluation of physical-chemical properties of toast breads fortified with pumpkin (*C. moschata*) flour. The 6th Arab and 3rd International Annual Scientific Conference on: Development of Higher Specific Education Programs in Egypt and the Arab World in Light of Knowledge Era Requirements. Faculty of Specific Education, Mansoura University, Egypt. 13-14 April 2011.

Elimam, H., Amir, M. and Mustafa, A. (2008) Effect of fermentation and particle size of wheat bran on the antinutritional factors and bread quality. *Pak. J. Nutr*., **7**(4), 521-526.

Elleuch, M., Bedigian, D., Roiseux, O., Besbes, S., Blecker, C. and Attia, H. (2011) Dietary fibre and fibre-rich by-products of food processing: characterization, technological functionality and commercial applications. *Rev. Food Chem*., **124**, 411-421.

Encyclopedia of Foods and Their Healing Power: Volume 1. (2004) Education and Health Library Editorial Team (Ed.). 2004, ISBN-10:8472081842.

Gomez, M., Ronda, F., Blanco, C. A., Caballero, P.A. and Apestegula, A. (2002) Effect of dietary fibre on dough rheology and bread quality. *Europ. Food Res. Technol*., **216**(1), 51-56.

Gry, J., Soborg, I. and Anderson, H.C. 2006. Cucurbitacins in plant foods. Nordic Council of Ministers, Copenhagen.

Hu, G.H., Yang, F., Ma, Z. and Zhou, Q. (2007) Development of research and application of rice bran dietary fibre. *China Food Addit.* **84**(5), 80-85.

Juna, H.I., Lee, C.H., Song, G.S. and Kima, Y.S. (2006) Characterization of the pectic polysaccharides from pumpkin peel. *LWT-Food Sci. Technol.* **39**, 554-561.

Kiharason, J.W., Isutsa, D.K. and Ngoda, P.N. (2016) Effect of drying method on nutrient integrity of selected components of pumpkin (*Curcubita moschata* Duch.) fruit flour. *Journal of Agricultural and Biological Sciences*. *In Press*.

Lee, C.H., Cho, J.K., Lee, S.J., Koh, W., Park, W. and Kim, C.H. (2002) Enhancing β-carotene content in Asian noodles by adding pumpkin powder. *Cereal Chemistry* **79**(4), 593-595.

Lee, F.A. (1983) Basic Food Chemistry. AVI Publisher, Westport. Pongjanta, J., Jomduang, S. and Panomwan Na Ayuttaya, R. (2003). Effect of processing and drying treatment on quality of pumpkin powder. *Food J*. **33**, 68-76.

Mnzava, N. and Mbewe, J.E. (1997) African traditional vegetables: Selecting dual-purpose local pumpkins, *Cucurbita moschata* (Duch. ex Lam.). Report.