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SENSORY QUALITY OF STIFF PORRIDGE (UGALI) PREPARED FROM PUMPKIN AND SOY BEAN SEEDS FORTIFIED MAIZE FLOUR

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ABSTRACT

Maize is a major food staple in most of the sub- Saharan African countries. Maize flour is mostly rich in carbohydrates, which provide energy to the human body. Nutritionally, maize flour is deficient in the other major diet requirements of proteins, vitamins and essential minerals. In this study, maize flour was enriched using pumpkin and soybean seed flours and the sensory qualities of the resulting composite flours were evaluated. Four formulations of maize, soy bean and pumpkin seeds flours were prepared by compositing various proportions of each ingredient. The flours were produced by grinding the seeds using a hammer mill to a particle size fine enough to go through a 1 mm sieve size. The composite flours were using to prepare stiff porridges (ugali), which is the popular format of preparation for this meal. Sensory quality of the flours and stiff porridges were evaluated. Sensory attributes evaluated for the composite flour ugali were aroma, color, texture, general appearance, smell, flavour, hardness, springiness, oiliness, taste and general acceptability. There was no significant difference in smell, appearance, texture, flavour, hardness, springiness across the formulations among the panelists.

A significant difference was observed on color, oiliness, taste, appearance. The mean score was above 5 for all parameters, which is in the middle of the 9- point hedonic scale. These findings indicate that generally all the formulations were accepted. The instrumentally evaluated results using a texture analyzer indicated a significant difference in hardness, cohesiveness and springiness in the stiff porridge samples. But all samples were accepted regardless of the differences, indicating that the differences were not big enough to influence the human sensory organs.

Keywords: Sensory attributes, maize, pumpkin and soy bean seeds, fortified maize flour, composite flour , stiff porridge, ugali.

1. INTRODUCTION

Food sensory evaluation can be defined as the analysis and interpretation of the identified and measured food product properties (Meilgaard *et al*, 2006). Human subjects are used because they are the consumers of the products; they have the ability to discriminate the difference between products; can describe characteristics that are found between products; and can indicate the preferences, liking or acceptability of products (Mongi, 2015). Through sensory evaluation, the food products quality can be evaluated or improved. This evaluation can provide inputs for decision making and product development, determine the market value of products, determine the shelf-life of products, determine ingredient substitution in product formulation, assist to

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compare products with the competitor's products, and determine storage conditions of the products (Anton *et al*, 2009).

Composite flours are a mixture of flours from tubers rich in starch(cassava, yam, sweet potato) and / or protein rich flours (soy bean, peanut)and / or cereals (maize, rice, millet, buckwheat) with or without wheat flour that created to satisfy specific functional characteristics and nutrient composition (Hasmadi *et al*, 2020).

The use of composite flours had advantages in terms of promotion of high-yielding, native plant species, a better supply of protein for human nutrition, and better overall use of domestic agriculture production. Composite flour has better nutritional value concerning elements of minerals, vitamins, fibers and proteins than flour milled from any specific cereal alone, that is composite flour mixture could provide a balanced nutrient (Noorfarahzilah *et al*, 2014).

The functional properties of composite flours play an essential role in the manufacturing of food products. The functional properties determine whether the blends would be useful in products. The functional properties of composite flour are an essential parameter to produce various food products that are good quality in terms of appearance, organoleptic, and acceptance from consumers. Composite flours have been used extensively and successfully in the production of food products (Hasmadi *et al*, 2020). Therefore this study aimed at determining the sensory quality and the mixing ratios of composite stiff porridge (*ugali*) flour which are crucial in commercialization of maize products.

2. MATERIALS AND METHODS

Samples

Pumpkin seeds, soy bean seeds and white maize were purchased from Chief Kingalu market in Morogoro region, Tanzania.

Sample preparation

Sorting and cleaning

White maize, pumpkin and soy bean seeds were sorted to remove extraneous matter and damaged grains, then washed to remove dust and mud.

Drying

The samples were dried overnight in an oven at 65°C according to the procedure described by Oyetoro *et al.* (2012).

Milling

White maize, pumpkin and soy bean seeds samples were milled into fine flour (sieve size-1mm) using a commercial hammer mill (Mzinga corporation, Morogoro, Tanzania).

Portions of the samples were stored in polyethylene packets to be used as a control in the quality evaluation of maize based diets and acceptability of the various formulations. The remainder of the samples was used to make the maize; pumpkin-soy bean seeds blend formulations.

Texture Analyzer

A texture Analyzer is a texture measurement system that moves in either an up or down direction ton compress or stretch a sample. The travelling arm is fitted with a load cell and records the force response of the sample to the deformation that is imposed on it (Luoet *et al*, 2019)

Sensory evaluation

Sensory analysis for the composite flour stiff porridges was carried out using a9-point hedonic scale. The panelists were provided with clean drinking water to rinse the mouth before testing

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each sample of *ugali* and in between tests. The samples of stiff porridge from four formulations of flours were evaluated on the same day as well as the same environment. The parameters were also evaluated instrumentally using a texture analyzer (Brookfield, 2011) for comparison with the sensory panel results.

Sample formulation and composition

Four formulations of white maize, pumpkin- soy bean seeds flours were developed using Nutrisurvey (2007) software; with at least half of the targeted amounts of the nutrients of interest in the study were taken.

Table 2. Composition of the pumpkin-soybean seeds fortified maize flour food formulations (g/100 g).

The ingredients maize, soybean and pumpkin seeds were mixed and then milled together to obtain the composite flour.

Sample	F1 %	F2 %	F3 %	F4 %	Control
Maize	70	65	60	55	100
Soy bean seed	10	20	30	40	0
Pumkin seed	20	15	10	5	0
Total	100	100	100	100	100

Preparation of Stiff porridge (*Ugali*).

Water was boiled then maize flour was gradually added to1 liter of boiling water (1: 2 w/v maize flour: water) and continuously stirring for 5 to 16 minutes until a uniform consistency and stiffness or until the uniform moderately hard dough or desired consistency of *ugali* was obtained.

Sensory Evaluation

Thirty trained panelists consisting of (number?) postgraduate and undergraduate students from Sokoine University of Agriculture evaluated stiff porridge samples made from the different blends formulations. All the panelists were briefed before the commencement of the evaluation process. Characteristics evaluated were: a) Appearance, b) Color, c) Mouth feel, d) Texture, e) Taste and f) Overall acceptability, g)Flavour, h) Oilness, i)Springess, j)Hardness, and k) Aroma . A 9 point Hedonic scale (Rangana, 1994) was used to measure the consumer acceptability of the products. The relative importance of each factor was compared numerically on a scale of 1 to 9; 1 = dislike extremely, 9 = like extremely). Each panelist gave a score. The average score of each sample was then calculated.

Statistical analysis

The design of the experiment was factorial design with three factors under consideration: white maize, pumpkin – soy bean seeds formulations. The results were presented as an average of two replicates. Sensory evaluation data were analyzed by two way ANOVA using R COMMANDER software program, Duncan's Multiple Range Test method were used to assess the difference between means at 95% confidence interval.

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Table 3. Characteristics of Consumer Panel (n=30)

Characteristics	Category	Frequency (N)	Percent (%)
Age	18-30	27	90
	31-45	3	10
Gender	Male	16	53.33
	Female	14	46.66

3.RESULTS AND DISCUSSION

The sensory evaluation of four different formulations of maize, pumpkin- soy bean flour is shown in table 2. Generally, it was observed that up on milling of maize, pumpkin- soy bean seed flour there was no significance difference in hardness, springiness, appearance, texture and general acceptability except for oiliness and aroma, flavor, taste, color, and smell due to the increase of soy bean and pumpkin seeds in the formulations.

Table 2.Acceptability of stiff porridge (ugali) made from the pumpkin-soy bean seeds fortified maize flour at different ratios

Sample	**Aroma**	**Color**	**Smell**	**Appearance**	**Taste**	**Oilness**	**Texture**	**Flavour**
F1	6.23±1.85^{a}	6.20±2.04^{b}	6.40±1.75^{c}	6.43±1.70^{d}	5.90±2.11^{a}	6.00±1.49^{a}	6.07±2.16^{c}	5.77±1.96^{f}
F2	7.13±1.38^{b}	6.87±1.41^{b}	6.63±1.75^{c}	7.00±1.37^{d}	5.97±2.37^{a}	5.60±2.11^{b}	5.77±2.24^{c}	6.03±1.97^{f}
F3	6.60±1.65^{c}	6.50±1.17^{b}	6.03±1.63^{c}	6.00±1.98^{d}	6.20±1.69^{a}	5.90±1.47^{c}	6.70±1.62^{c}	6.10±1.56^{f}
F4	6.63±1.75^{c}	6.50±1.55^{b}	6.57±1.36^{c}	6.90±5.29^{d}	5.60±1.69^{a}	8.47±12.47^{b}	6.10±1.56^{c}	5.79±1.66^{f}
Control	8.21±1.18^{b}	6.97±1.41^{a}	7.57±1.34^{c}	7.10±1.78^{d}	7.90±3.21^{b}	5.00±1.36^{a}	6.09±2.11^{c}	7.03±1.65^{e}

Hardness	**Acceptability**	**Springness**
5.83±1.95^{k}	6.73±2.16^{a}	6.27±1.74^{k}
6.73±1.46^{k}	7.10±1.32^{a}	6.10±1.97^{k}
5.93±1.80^{k}	6.43±1.68^{a}	5.67±1.88^{k}
6.40±1.77^{k}	6.33±1.58^{a}	6.03±1.67^{k}
6.84±1.86^{k}	7.43±1.41^{a}	6.14±1.68^{k}

Sensory attributes

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Table 2 shows the acceptability of four *ugali* sample made from pumpkin –soy bean seeds fortified maize flour; It was observed that the color, smell, appearance, texture, springiness, flavour, hardness, taste, general acceptability were not significantly different in all pumpkin-soy bean seeds, maize flour stiff porridge sample; while the aroma and oiliness of the Ugali was significantly different in all formulations. Generally, the different formulation of "ugali" samples was all acceptable.

Aroma

Aroma is an integral part of taste and general acceptability of the food before it is put in the mouth. It is an important parameter when tasting the sensory attributes of the formulated foods. The variation observed in aroma could be associated by effect of cooking. There was a significant difference in aroma that was contributed by the variation in amount of soy bean pumpkin seeds and white maize. These results were similar to report (Kitunda *et al*, 2020) that found there was significant difference in aroma on ugali made from the blends of unrefined maize flour (Dona) and cassava flour (HQCF) and stiff porridge (ugali) made from the blends of refined maize flour and cassava flour (HQCF) with ugali made from the blends of sorghum flour and cassava flour (HQCF) at different ratios at different ratios. The aroma refers to the product smell. The aroma of food product influences the preference of that product, as it affects acceptability. The good smell attracts acceptance of the products

Color

Color hue is an important attribute in food choice as well as acceptability It was observed that there was no significant difference in color for all the samples of stiff porridge (ugali). This is due to the fact that the high amount of white maize dominates for the all formulation 70%, 65%,60% and 55% compare to the amount of pumpkin- soy bean seeds. Color is among the attributes that lead to product liking and acceptability. It influences the consumer toward that product, although the consumers differ in color preferences, but overall, the product color highly influences the sale of that product. The consumers always look for the resemblance between the new products with the previous experience they have about those types of products.

Taste

Taste is an attribute that surpasses other attributes in food products. This is because most food products are defined by their taste. The food product may be superior in other attributes such as color, springiness and hardness but poor taste negatively affects the product. The product taste can be expressed in its saltiness, sweetness, sourness, and bitterness. The taste of stiff porridge samples under study was much influenced by pumpkin- soybean. It was observed that there was no a significant difference in the taste of the stiff porridge samples which means the products tested more likely the same. This was because due to relatively high content of maize flour in each formulation controlled the taste. The difference in formulations did not bring any significant difference on the stiff porridge taste. The results shows that formulation (F3)was most acceptable than the other. (Ognean, 2015) found that the smell and taste of breads with sorghum remained pleasant even at 40% replacement of wheat flour.

Texture

Texture is a sensory property and, thus, only a human being (or an animal in the case of animal food) can perceive and describe it. The so-called texture testing instruments can detect and quantify only certain physical parameters which then must be interpreted in terms of sensory

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perception. In general, texture is more important for solid foods than for liquid ones. (Firoozmand, 2015).The texture of food is thus closely related to the physical structures and mechanical properties, and it directly affects the acceptability and purchase of a product by the consumer. Consumers generally have varying expectations of texture for different types of food. Consequently, many different terminologies, such as springiness, firmness, juiciness, toughness or tenderness, hardness, chewiness, stickiness and gumminess, are used to describe various textural characteristics for different food products (Cen and Lu, 2013).The importance of the texture of foods for its acceptability varies widely depending on the type of food. Texture determines to a large extent the identity of a food product, after blending food products (de Jong *et al*, 2009).From the formulationF1, F2, F3, and F4 of stiff porridge sample it was observed that there was no significant different in texture at $p \leq 0.05$, this indicates the acceptability of the products regardless of different formulations of maize, soy bean and pumpkin seeds.

Flavour

Flavour is the sensory impression of a food or other substance, and is determined mainly by the chemical senses of taste and smell. flavor**,** attribute of a substance that is produced by the senses of smell, taste, and touch and is perceived within the mouth. Tasting occurs chiefly on the tongue through the taste buds. The taste buds are stimulated fundamental by taste sensations sweet, salty, sour, and bitter. From the four formulation$5.77 \pm 1.6\ 6^{f}$ and5.79 ± 1.97^{f}, 6.03 ± 1.97^{f} $^{6.10} \pm 1.56$ the mean score i >5 which indicates that there was no significant different in sample formulation for the case of flavor regardless of different mixed ratios. All the sample formulation was acceptable.

Smell

Smell is the faculty or power of perceiving odors or scents by means of the organs in the nose. The rating of smell of different sample was rated 6.63higher mean and 6.03was a lowest mean, the sample formulation was like slightly at $p \leq 0.05$ which indicates there was no significant different in a product sample, all formulations were acceptable. This can be caused by the same ingredients used in all formulation.

Oiliness

O illness is one of the various sensory expressions for foods containing oils and fats. This term is associated with several complex senses and is used for various foods whether they are preferred or not. It is affected by texture and distribution of fats and oils, in which may involve a complex relationship between physical and chemical mouth feel. In the formulation sample 4 shows the highest mean score of 8.47 and sample 2 the mean was 5.60 and control sample was 5.00 at $p \leq 0.05$ indicates that there was significant different in stiff porridge sample due to the ratio of soy bean and pumpkin seeds variation. But all the sample formulation was accepted.

General Appearance

It is determined by surface color is the first sensation that the consumer perceives and uses as a tool to either accept or reject food. It is a criterion for consumer to judge the quality of food. For the four formulations and control sample the sensory results indicates that there were no significant different in appearance between samples formulations. This was due to the fact the high ratio of maize dominates the formulations. Since the mean score was >5 all samples formulation was accepted by the panel members.

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Hardness

Is the mechanical textural attribute relating to the force required to compress the sample. The force that is required to compress food between the tongue and palate to a given deformation or to penetration. Hardness is dependent on ductility, elastic stiffness, plasticity, strain, strength, toughness, viscoelasticity, and viscosity. For the hardness characteristics in F1,F2, F3 and F4 and control sample formulations show there were no significant different with the formulation, and all samples was accepted in terms of hardness.

Springiness

Mechanical textural attribute relating to the rapidity and degree of recovery from a deforming force. It is done by compressing the sample partially with fingers and evaluates the degree and rapidity of recovery. It also determines products acceptability, for the study it shows there were no significant different on developed products at $p \leq 0.05$, that means the formulated product samples were accepted to the panelist but formulation 65%, 20%,15%(F2) and55%,40%,5%(F4) for the (maize, soy bean- pumpkin) are more liked than others.

General acceptability

The score of samples attributes contributes to the general acceptability of the whole product. The general acceptability had the highest mean which was 6 an7 indicates like slightly and like moderate compared to other attributes, which means the panelists positively responded to the ugali product sample displayed. It was observed that there was no significant difference in general acceptability of the different samples under study. This indicates no intense variation observed on the panelist acceptability of the products. It can be expressed that any of the white maize, pumpkin –soybean can be used for stiff porridge flour development and it would not significantly affect the acceptability of such products, under the studied formulations. The acceptability score predicts the products performance in the market since the consumers show the willingness of buying the product.

Evaluation of the parameters using a Texture Analyzer

The various parameters were evaluated using a texture analyzer. These are presented in Tables 4 to 6 and using radar charts (Figures 1 to 3) below**;** The table 4, 5 and 6 above and figure 1,2 and 3 shows the results of sensory evaluation for the hardness and springiness, and cohesiveness of stiff porridge (ugali) measured by using texture analyzer.

Table 4. Springiness results from texture meter

S/N	Parameter	Sample F1	Sample F2	Sample F3	Sample F4	Control
1	Springiness (mm)	9.7±0.014 e	10.01±0.014 d	9.85±0.071 f	10.19±0.000 h	8.56±0.004 a
2	Deformation(mm)	14	9	9.7	10.2	9.3
3	Energy((Mj)	9.45	8.5	9.9	9.1	8.9
4	Temperature oC	66	72	70	64	79

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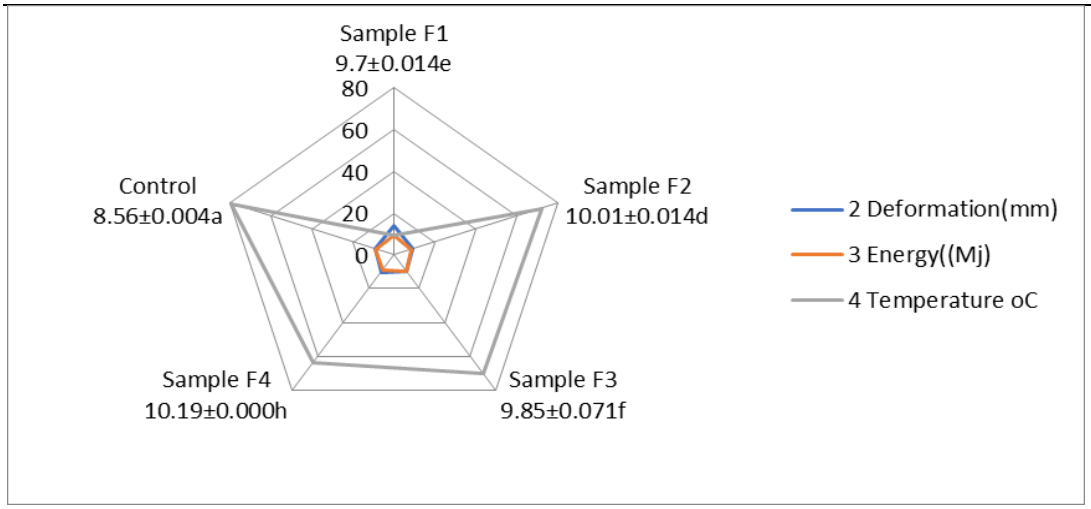

Figure 1. Radar chart presenting Springiness

Table 5. Hardness results from Texture Analyzer

S/N	Parameters	Sample F1	Sample F2	Sample F3	Sample F4	Control
1	Hardness (g)	237.5±23.33^{a}	134.85±2.90^{e}	115.5±0.707 c	94.5±0.707 d	88.43±13.32 e
2	Deformation(mm)	14	9	9.7	10.2	9.3
3	Energy(Mj)	9.45	8.5	7.9	9.1	8.9
4	Temperature Oc	66	72	70	64	62

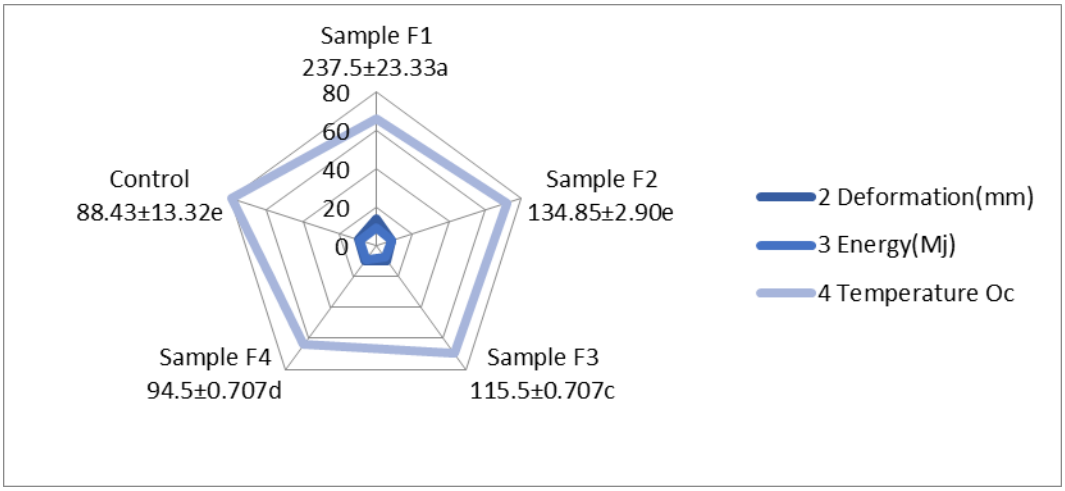

Figure 2. Radar Chart presenting Hardness

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Table 6. Cohesiveness results from texture analyzer

S/N	Parameter	Sample F1	Sample F2	Sample F3	Sample F4	Control
1	Cohesiveness	0.88±0.000 e	0.93±0.014 d	0.97±0.061 f	1.23±0.014 h	94.56±0.004 a
2	Deformation(mm)	14	9	9.7	10.2	9.3
3	Energy((Mj)	9.45	8.5	9.9	9.1	8.9
4	Temperature oC	9.45	72	70	64	79

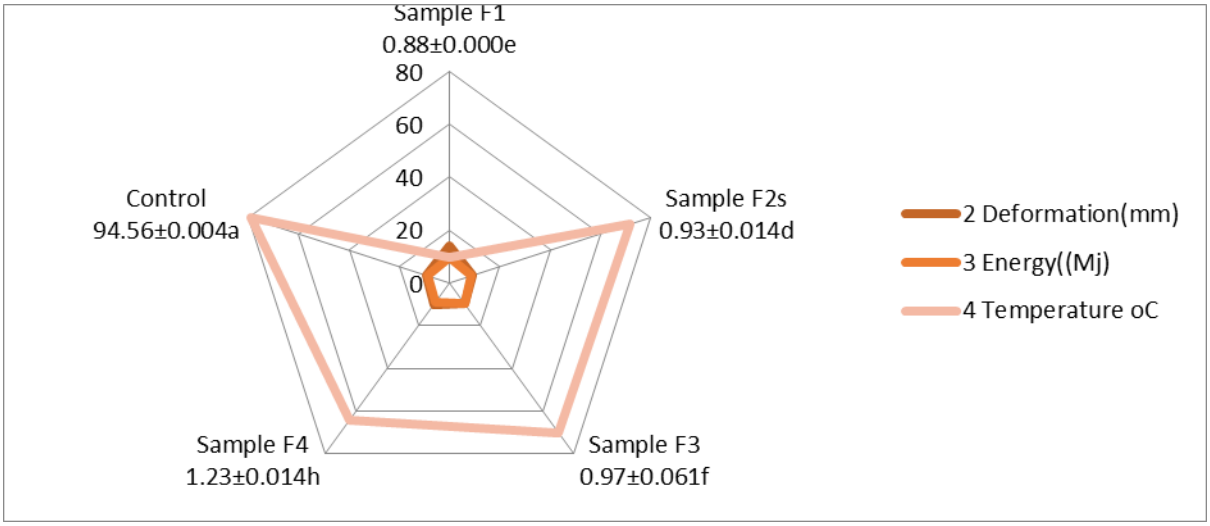

Figure 3: Radar Chart Presenting Cohesiveness

From the results it shows that there was significance difference in all four sample formulation and control sample of stiff porridge made from maize, Soy bean- Pumpkin seed flour in hardness, cohesiveness and Springiness which was opposite from the results made from human panelist members which detect there was no significant difference in attributes for all sample formulation at $p \leq 0.05$, this was similarly reported by (Dabash *et al*, 2017) that panelist did not recognize any significant differences between samples of rice and pumpkin d=seed flour. This significant difference does not affect the acceptability of the products; all formulation was accepted by the panelist members.

Formulation number F1 had the highest score of hardness and F4 had the lowest score this can be due to the variation in the amount of ingredients during milling, temperature changes at a time of measurement, and food homogeneity. It showed that the stiff porridge with low temperature score highest in hardness compared with the one with high temperature as shown in table 5 above. This significant different was reported by

(El Sohaimy *et al* 2020) who made pasta fortified with chickpea flour (CF) and chickpea protein isolate (PI) where hardness continued in elevation in accordance with increased CF and PI substitution concentrations.

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Formulation F1 had highest score of hardness and lowest score in springiness and cohesiveness this was due to the fact that as the amount of pumpkin seeds increases the hardness increases, while springiness and cohesiveness decreases. This finding was similar to (Aukkanit, 2007), that the hardness of noodle dough increased as the amount of Pumpkin seed flour increases (Dabash *et al.* 2017). It was reported by this author that the hardness of rice bread was increased by the presence of pumpkin seeds flour, while springiness and cohesiveness were decreased by the presence of pumpkin seeds flour. This was due to the fact that pumpkin seeds flour increases the thickness, elasticity and decrease the moisture content of ginger bread which lead to hardness (Garkina *et al,* 2021),

Formulation F4 scored highest in springiness and cohesiveness as indicated in radar and column chart above due to the increase in the amount of soy bean seed flour, similar reported by (Alamuet *et al,* 2021) that the increase in soy bean flour increases springiness and cohesiveness in ginger bread, was due to fact that soy bean flour increase firmness and density due to soy bean fiber, also the interchange of disulfide bonds between soy bean and protein from maize flours, and the absorption of water by soy bean fiber causing increase in springiness (Alamuet *et al,* 2021).

4. CONCLUSION AND RECOMMENDATION

The study showed that the stiff porridge sample formulation and control sample were all accepted by the panelist, the significant different from texture measurement does not affect the overall product acceptability. The difference in ratios between formulation results in hardness, cohesiveness and springiness different among the formulations, the F1sample score highest in hardness and lowest in springiness, and cohesiveness formulation F4 had highest score in springiness and cohesiveness attributes. The difference was due to the amount of soy bean and pumpkin seeds, while F4 had low pumpkin seeds and high soy bean seeds, the reason behind was that the increase in pumpkin seed flour in F1 increases the fat in the formulation, because pumpkin seeds contain high fat content compared to soy bean seed flour. This is because of the influence of Polyunsaturated Fatty Acids (PUFA) (USDA, 2016). Pumpkin seeds are rich in linoleic fatty acid, oleic acid and linolenic acid (Pujilestari *et al,* 2017). The fats content in pumpkin seeds flour absorb water during cooking, hence increasing the hardness (Rodge *et al,* 2012). Therefore, soybean and pumpkin seeds flour improve the textural and sensory quality of stiff porridge, and since the formulations are practical, they are acceptable.

This work recommends the promotion and utilization soybean flour, maize and pumpkin seeds flour in stiff porridge making in Tanzania. However, further research work should be focused on how to improve sensory quality to enhance overall acceptability of the final composite stiff porridge.

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