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Developing a high protein-energy cereal blend using locally produced small grain cereals and legumes

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Abstract

The overall aim of the study was to develop a high energy-protein cereal for vulnerable groups utilising small grains generally grown in marginal agro-ecological regions of Zimbabwe. Two cereal blends were prepared as soya blend cereal (millet, rapoko, sorghum and soya) and groundnut blend cereal (millet, rapoko, sorghum and groundnut) for improving flavour, palatability and therapeutic value. A mixing ratio targeting 15% Crude Protein (CP) was determined using Pearson Square Method. The cereal blends were tested for chemical characteristics and a 9-point hedonic scale ranging from dislike extremely (1) to like extremely (9) was used for sensory evaluation. Data were analysed using SPSS version 17.0. It was observed that the cereals were within the standard range of 15% CP. The sensory evaluation score was higher with the groundnut blend due to its better flavour and colour appeal. It was also observed that the addition of sugar and salt improved the flavour and palatability of both blends. On the basis of the results revealed in the study, it was concluded that it is possible to blend small grain cereals with legumes to produce a likable nutritious cereal.

Keywords: High energy-protein, Vulnerable group, Small-grain, Cereal blend, Sensory evaluation

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1. Introduction

The world over, cereals and cereal products are significant and important human food resources worldwide and the most basic staple food for many countries and cultures (Butterman & Bianchini, 2011). Coulibaly, Kouakou and Chen (2011) think it is because of their good acceptability on the organoleptic properties and their low cost that make them accessible to the underprivileged populations. Small grain cereals such as millet, rapoko and sorghum are drought resistant cereal crops which grow very well in arid areas. Diekmann (2009) notes that small grain cereals, in their natural state, are considered to be one of the most important sources of carbohydrates, proteins, vitamins, mineral elements and dietary fibre and because of their genetic variability are extremely adaptable to different environments. It is therefore the intentions of this study to promote the utilization and consumption of the small grains contributing to household food security. This is in support of FAO which has added to its list sorghum and millet in human nutrition (Lupien, 1995). The enrichment of the cereals with soya or groundnuts will enhance the utilization of protein whose bioavailability is affected by phytic acid present in cereals.

Legumes play an important role in the traditional diets of any regions because they are low in saturated fats and are an excellent source of proteins, complex carbohydrates, dietary fibre, a variety of micronutrients and phytochemicals (Massina, 1999). It is further stated that soya beans are unique among the legumes as they are high in isoflavones which have attracted interest in research, as they have a potential of preventing and treating chronic diseases such as cancer, osteoporosis and heart diseases. It is hoped that blending of two or more cereals with legumes will produce an economic wholesome, nutritious breakfast cereal which will also bring variety in the diet and market at large.

The development of the cereal is the key to improving nutrition for the vulnerable, that is, people living with HIV/AIDS PLWHA, the under-5s and pregnant women through an inexpensive cereal product. In support, WHO (2012) states that malnutrition is the underlying contributory factor in over one third of all child deaths, making children more vulnerable to severe diseases. This will accelerate the attainment of the nutrition related Millennium Development Goals (MDGs) 1, 4, 5 and 6. It is also a health promotion and preventive approach for the vulnerable groups. Research has shown that the chance of infection with HIV virus might be reduced in individuals who have good nutrition status with micro nutrients (Egal and Valstar, 1999). In this view, the product focuses on protecting and promoting people's health through research. Above all, the product is a wholesome cereal with all the nutrients, including micro nutrients to help alleviate hidden hunger and minimize onset of chronic diseases.

Furthermore, this research promotes utilization and consumption of small grains, contributing to household food security. The research can also open up markets for small grain producers in marginal agro-ecological regions thereby eradicating rural poverty.

2. Materials and methods

2.1. Small grains, soya beans and groundnuts collection

Millet, rapoko and sorghum were procured from a local market in Harare. Soya beans and groundnuts were donated by colleagues.

2.2. Preparation of the small grains

Millet, rapoko and sorghum were separately pound with little water added using mortar and pestle to loosen the husks. The grains were then winnowed to remove the husks. The grains were also rinsed in cold water to remove any residue of the husks, then spread and dried in the sun in a winnowing basket, turning them in the process, to speed up and ensure complete dryness. The dried grains were roasted in a saucepan on the stove to develop the flavour. After roasting the grains were ground into a fine meal using a hammer mill. The process resulted in three meals, that is, the millet, rapoko and sorghum meals.

2.3. Preparation of the soya beans and groundnuts

The shelled soya beans and groundnuts were roasted separately in a saucepan. The skins were loosened by rubbing the pulses with palms rubbing against the winnowing basket. The skins were then winnowed off using a winnowing basket. The soya beans and the groundnuts were pound separately into powder and sifted through a sieve to get a fine powder.

2.4. Formulation of the cereal blends

Processed sorghum, rapoko and millet grains were first ground into meals and mixed in equal proportions to form one composite small grain meal (SGM). The legumes were roasted, de-hulled and milled. Using the Pearson Square Method, mixing ratios of 2:1 SGM to groundnut meal and 6:1 SGM to soya meal were established. The small grain and legume meals were mixed three times to ensure a thorough mix was formed.

2.5. Chemical analysis

The formulated cereal blends were taken through a proximate scheme. Ca content was established by wet method, EDTA. Ca was precipitated from ash solution and titrated with EDTA, in the presence of Mg^{2+} ion, with EBT. P content was established by reading absorbance of phosphomolybdenum blue at 630nm. Chemical analysis results are presented in Table 1.

2.6. Cereal preparation

Water was boiled for each cereal blend. A paste of each of the cereal blends was made and added to boiling water to make porridge. The porridge was stirred continuously and brought to the boil, then simmered for 30 minutes. Sugar and salt were added to taste.

Table1. Nutritional analysis of the cereal blends

Blend	*%DM*	*%ASH*	*%Ca*	*%P*	*%CF*	*%CP*	*%EE*
Soya	92.2	1.66	0,14	0.2	2.59	15	3.62
Groundnuts	92.76	1.32	0.1	0.2	2.5	14.81	16.17

DM = dry matter, ASH = Inorganic material, Ca = Calcium, P = Phosphorus, CF = Crude fibre, CP = Crude protein, EE = Ether extracts

2.7. Sensory evaluation

Organoleptic evaluation of both cereal blends was performed by an untrained sample of the University of Zimbabwe community. The cereal blends were subjected to a 9-point hedonic scale test ranging from dislike extremely (1) to like extremely (9). Fifty-three panelists were selected from the academic staff and students at the University of Zimbabwe, to evaluate sensory characteristics such as flavour, consistency, colour, taste, blending quality and overall liking of the cereal blends. Data were subjected to statistical analysis using SPSS version 17.0.

3. Results and discussion

Acceptability of the samples was judged by fifty-three untrained members to determine preference on a 9-point hedonic scale for a set of attributes: taste, flavour, texture, colour, consistency and blending. The participants judged each small grain-cereal blend on a 9-point hedonic scale: 9=like extremely, 8=like very much, 7=like moderately, 6=like slightly, 5=neither like nor dislike, 4=dislike slightly, 3=dislike moderately, 2=dislike very much, 1=dislike extremely. SPSS Statistics version 17.0 was used to establish sample means and standard deviations (Table 2) and significance values (Table 3).

The following interpretation of the 9-point hedonic (acceptability) scale was used for discussion of the cross tabulation sample mean results: Like moderately to like extremely (average mean score 6 and above) were considered the “positive’ or “liked” part of the scale; dislike slightly to like slightly (average mean scores 4-5) were considered the “neutral” part of the scale and dislike moderately to dislike extremely (average mean scores below 4) were considered the “negative” or “disliked part of the scale.

The participants liked the taste of soya based cereal (average mean score 6) but were neutral for groundnut based cereal (average mean score 5). The difference in liking the taste was significant (p=0.005). Participants were neutral for the flavour of soya (mean score 4.75) but liked the flavour of groundnut based (mean score 6). The difference in liking the flavour was also highly significant (p=0.001). The participants were neutral for the texture of both cereals and liked the consistency and blending of both cereals. They, however, differed significantly (p=0.000) on the colour appeal of the cereals. The colour of groundnut cereal was found more appealing (mean score 6.34) than soya based (mean score 4.45). The participants expressed a significant higher overall liking of groundnut based blend over soya (p=0.000).

Table 2: Participants' mean rating of test attributes for the two cereals (n=53)

Type of blend		Taste	Flavour	Texture	Colour	Consistency	blending	Overall liking
Soya blended small grain-based cereal	Mean	6	4.75	5.28	4.45	6.19	6.3	7.28
	N	53	53	53	53	53	53	53
	S D	1.359	1.616	1.725	1.294	1.991	1.17	0.744
Groundnut blended small grain-based cereal	Mean	5.13	6	5.13	6.34	5.91	6.4	8.49
	N	53	53	53	53	53	53	53
	S D	1.721	2.21	1.606	1.881	1.863	1.378	0.724
Total	Mean	5.57	5.38	5.21	5.4	6.05	6.35	7.89
	N	106	106	106	106	106	106	106
	S D	1.604	2.026	1.66	1.865	1.924	1.273	0.949

Table 3. ANOVA for test attributes by type of blend

		Sum of Squares	df	Mean Square	F	Sig.
Taste	Between Groups	19.962	1	19.962	8.302	.005*
	Within Groups	250.075	104	2.405		
	Total	270.038	105			
Flavour	Between Groups	41.094	1	41.094	10.964	.001*
	Within Groups	389.811	104	3.748		
	Total	430.906	105			
Texture ns	Between Groups	0.604	1	0.604	0.217	0.642
	Within Groups	288.83	104	2.777		
	Total	289.434	105			
Colour appeal	Between Groups	94.34	1	94.34	36.202	.000*
	Within Groups	271.019	104	2.606		
	Total	365.358	105			
Consistency ns	Between Groups	2.123	1	2.123	0.571	0.452
	Within Groups	386.642	104	3.718		
	Total	388.764	105			
Blending ns	Between Groups	0.236	1	0.236	0.144	0.705
	Within Groups	169.849	104	1.633		
	Total	170.085	105			
Overall liking	Between Groups	38.642	1	38.642	71.763	.000*
	Within Groups	56	104	0.538		
	Total	94.642	105			

4. Conclusion and recommendations

It was concluded that the groundnut cereal blend was most preferred. The overall liking score was higher in the groundnut blend due to its higher score in flavour and colour appeal. On the basis of the results revealed in the study, it may be concluded that it is possible to blend small grain cereals with legumes to produce a likable nutritious cereal. Overall the formulated products contribute to quality protein by essential amino acid compensation, are of low cost and allow an increase in availability of products for gluten intolerant people (Cerezal Mezquita et al., 2011). It is recommended that further studies be carried out to establish the shelf life of the product and reduction of cooking time. With funds permitting, it is also recommended that further research be done to develop the cereal product into ready to eat snacks such as biscuits and crackers.

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