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Development and evaluation of a Sorghum/Soy weaning food

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Abstract

A weaning food was developed from sorghum/soy blend by extrusion cooking on a single screw extruder. A three factor factorial study was conducted at three levels of feed moisture (20, 30 and 40%), three levels of sorghum variety (Epuripur, Sekedo and local) and three levels of soybean level (10, 20 and 30%). Feed moisture of 30% and decreased as the moisture was increased further. WSI and NSI increased with decreasing feed moisture. Epuripur produced products with the best attirbutes compared to the other two varieties, whereas increasing the soybean level did not have any significant effect on the functional attribute of the product.

Introduction

Despite the hard work and commitment that many organisations have put into fighting hunger and malnutrition, the world today still has a strong image of malnutrition. it is the image of a child with eyes too large for a face that is old before its time, a child almost too weak to lift the empty bowl to be filled with food donated from overseas. But according to UNICEF (1998), this is an unusual and extreme form of malnutrition affecting less than 1% of the developing world's children and almost always as a result of some quite exceptional circumstance such as war, or famine, or both.

But there is another malnutrition, which is not visible, either to parents or health workers or to a worldwide public. It is the malnutrition of the 1-year-old child who weighs only 6 kilos, of the child who rarely joinsthe games and adventures of others, of the child whose eyes are glazed over behind a school desk and who does not understand or remember what he or she is being taught. This is the protein-energy malnutrition that, in some degree, affects over one third of all the children under five in the developing world. It is not caused by lack of any one particular nutrient, but by the complex interaction of poor diet and frequent illness. Malnutrition is not, as many think, a simple matter of whether a child can satisfy immediate hunger can still be malnourished. In developing countries where malnourished children are usually found, most problems start during weaning. Children are often weaned on starchy-bulky gruels which have low energy and nutrient density (King and Ashworth, 1991).

A massive increase in the supply of vegetable protien and calories processed insuch a way as to increase the energy and nutrient density as opposed to the boosting of the supply of animal protein would present less difficult, less expensive, and more energy prospects in developing countries. Cereals and food legumes are leading candidates in this aspects since they can be easily grown in developing countries and are relatively high in energy and/or high quality proteins. In Uganda, locally available cereals such as sorghum and millets and legumes such a soybeans and garden beans if complemented and properly processed, may offer the ever-elusive solution to the country infant malnutrition problem.

Background

Sorghum

sorghum is the fifth most important cereal in the world and the third most important in Uganda after maize and millet. Though its production has steadily increased as a result of the increase in acreage under production, its proprtion among the cereals and other crops has been decreasing. Whereas in 1980 it accounted for close to 30% of the total cereal production in the country, by 1994 it accounted for hardly 20% (background to the budget 1996). limited utilization base was most likely one of the major reasons for the decline in proportional production. The incentive to produce by sorghum production breeders will depend in part on the ability to utilize the increased amounts produced. because of its higher yeilds on marginal soils and under harsh climatic conditions relative to other crops it could offer a better solution than resorting to importation in times of scarcity. The potential of sorghum as a food resource of strategic importance in the semi arid tropics is well documented but more efforts are still needed to transform this potential to tangible results.

However, the use of sorghum, especially in its unprocessed form, as a raw material for weaning foods is not without problems. Like all the other starchy food crops, infant foods made from it are likely to be of low energy and nutrient density and is generally low in proteins. Besides, some varieties are high in phenoic compounds (tannins), which are known to bind enzymes and other proteins. Therefore, in order to be effectively used, complementality with high protein foods and desirable processing are needed. Malting, the controlled germination and subsequent drying of seeds, has been reported to lower the viscosities of the resulting gruels (Brandtzaeg et al., 1981). Enzymatic reactions taking place during this process are believed to change the nature of the phenolic compounds and phytic acid, and thus improve the availability of nutrients. "power flour", a locally produced weaning food in Tanzania, is one case where this method is used (Tompkins et al., 1987). Fermentation is another method traditionally used in many parts of the world. It is a microbial breakdown of starch to lactic and acetic acids. Like malting, it also improves the texture and taste of the resulting products. The problem with these traditional methods is that they are prone to contamination with pathogenic and spoilage microorganisms. On the other hand, the addition of fats, though advantageous in as far as increasing the energy density and provision of essential fatty acids, decreases the shelf life as the product will be susceptible to off flavors due to rancidity. Extrusion cooking addresses, one of these constraints and has been tried in many developing countries with a high degree of success.

Extrusion cooking

Extrusion cooking is often regarded as a high temperature short time processing method which, in a single process is capable of mixing, forming, texturing and cooking leading to a wide range of desirable functional and nutritional properties. For a technology that is hardly 40 years, it represents one of the fastest growing technologies in recent years. Though high in capital in capital investment, its operational costs are lower than those of comparable processes such drum drying and spray drying. (Harper 1981). Because of its versatility, it is becoming popular in many developing countries where it is used mainly for processing weaning foods. In Uganda there are so far at least three companies with extruders. Extrusion cooked weaning foods are lower in viscosity and thus higher in energy and nutrient density compared to unextruded ones (Njoki and Faller 2001) and those processed on a drum dryer (Anderson 1969).

But with a technology so new and a wide selection of raw material and processing variables, the need for optimization cannot be overemphasized.

Objectives

The overall objective of this study was to develop a sorghum/soy based extruded weaning formula which is acceptable and affodable.

Specific Objectives

- Determine the effect of sorghum varieties on the functional and nutritutional properties of the resulting product.
- Determine the effect of changes in soybean levels on the functional and nutritutional properties of the product.
- Determine the effect of changing the feed moisture on the functional and nutritutional properties of the final product.
- Establish the optimal combination of the feed material and processing conditions for the development of a sorghum/soy weaning food.

Materials and methods

Materials

Three varieties of sorghum, one white and two dark colored, were used in the study. The white one (Epuripur) and one of the dark colored ones (Sekedo) were obtained from Serere Agricultural and Animal production Research Institute (SAARI), while the other dark one bought from a local market.

Methods

Feed preparation

The feeds were prepared by combining the different varieties of srghum with different levels of soybeans as shown in Table 1.

Extrusion

Extrusion was done on a single screw extruder coutesy of Maganjo grain millers. Feed moisture was varied at three levels as shown in table 1.

Experimental design

The study 3x3x3 factoial design. The factors was, variety at three levels (EP. SE. LOC), feed moisture at three levels (20%, 30%, 40%) and soybean level at three levels 10%, 20% and 30% into an evaporating dish of known weight. WAI was calculated as total moisture absorbed divided by the weight of sample.

Analyses

Chemical and functional analyses

The finished samples was analysed for water absorption index (WAI), water solubility index (WSI), and nitrogen solubility index (NSI).

Water absorption index and water solubility index

Water Absorption Index(WAI)

The water absorption index is the weight of gel obtained per gram of dry sample upon hydration under standard conditions was determined by the method described by Anderson et al (1969a). Gound product passing through a 60 mesh screen was suspended in 30 ml of water at 30°C for 30 minutes, then centrifuged at 3000xg for 10 minutes. The supernatant was decanted into an evaporated dish of known weight. WAI was calculated as total moisture absorbed divided by the dry weight of sample.

Table 1. Experimental plan

Soybean Level (%)	Variety								
	Sekedo			Epuripur			Local		
	Feed Moisture %			Feed Moisture %			Feed Moisture %		
	20	30	40	20	30	40	20	30	40
10	*	*	*	*	*	*	*	*	*
20	*	*	*	*	*	*	*	*	*
30	*	*	*	*	*	*	*	*	*

Water Solubility Index (WSI)

Water solubility index was determined by dividing the amount of solids recovered from evaporation of the supernatant from the WAI test by the weight of the original sample, expressed as a percentage.

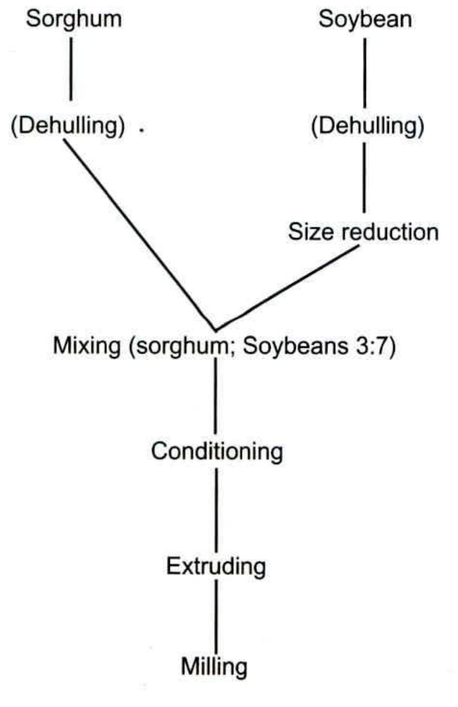
Nitrogen solubility index

Nitrogen solubility index was determined by the AACC method 46-24.

Statistical analysis

ANOVA/MANOVA procedure of STATISTICA statistical programme was used for date analysis, while the 3D surface quadratic surface response graphs procedure was used to generate the surface response graphs.

Figure 1. Processing of a sorghum baesd weaning food



Results and discussions

Nitrogen solubility index

Nitrogen solubility index(NSI), provides information on thermal denaturation of proteins. Partially denatured proteins are more digestible and have better foaming and emulsifying properties than do proteins in thier native state (Srinovasan, 1996). Therefore, for foods meant for infants, a lower NSI as an indication of partial denaturation is preferred.

As shown in Fig. 2, increasing feed moisture increased NSI. The results therefore seem to indicate that the lower the moisture content, the higher the denaturation, and thus the better the resulting products. Earlier studies had also shown the same (Njoki and Faller, 2001) Fig. 2, also shows that of the varieties that are used, Epuripur, a white variety, gave products with hihger NSI. This can only be explained by a difference in the chemical composition in the different varieties. It

Figure 2. effect of feed moisture and variety on NSI
z=22184.46+0.02*x-436.873*y-7.088e-4*x*x+0.003*x*y+2.151*

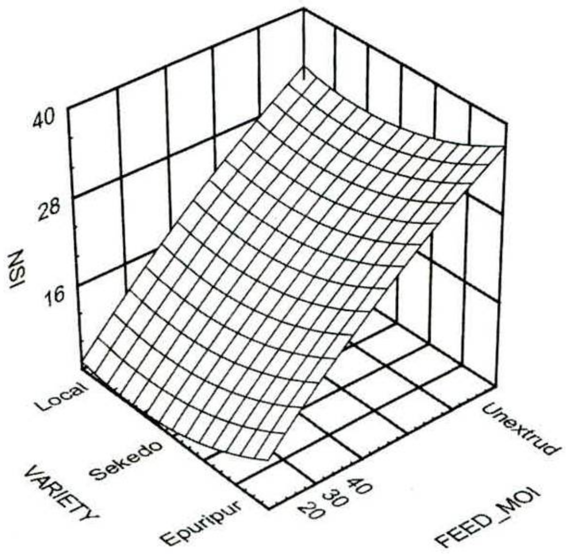


Table 2. Summary of the statistical analysis results

Parameter	Level	NSI	WSI	WAI
Feed Moisture	20	9.73^{a}	37.09^{a}	2.50^{a}
	30	12.61^{b}	31.06^{b}	4.57^{b}
	40	15.89^{c}	23.62^{c}	3.31^{c}
	Unextruded	30.99^{d}	15.14^{d}	1.40^{d}
Soybean	10	15.86	34.33	3.78
	20	11.08	28.97	3.29
	30	11.30	28.47	3.31
Variety	Epuripur	13.99^{a}	31.05	3.52
	Sekedo	12.93^{b}	29.89	3.48
	Local	11.31^{c}	30.83	3.38

is possible that the tannins and other phenolic compounds, known to be higher in the colored varieties, bind the proteins and make them less soluble. The lower solubility in the colored varieties should not be taken to mean that that are better nutritionally since the compounds binding the proteins could bind them even during digestion.

The interaction between variety and feed moisture was not significant as shown both in Fig. 2 and in the mean separation during statistical analysis.

Water Solubility and Absorption

Water absorption index (WAI), a measure of the extent of gelatinization, was higher for the extruded samples than the unextruded ones (Table 2). Dahlin and Lorenz (1993) reported similar observations for laboratory extruded cereal grains. Among the extruded samples, only feed moisture had a significant effect on WAI. It was highest at feed moisture of 30%, but low for samples extruded at the lower feed moisture (Figure 3). Gujska and Khan (1991) reported similar results with cassava flour. Given the fact that WAI increases with the degree of gelatinization, the opposite would be expected since at lower feed moisture the product temperature was expected to be higher since there is less lubrication. The lower WAI at lower feed moisture content was most likely due excessive dextrinization of starch and should thus not be misinterpreted to mean less gelatinization or availability of nutrients.

Figure 3. effect of feed moisture and variety on WAI z=2798.45+0.393*x55.244*y-8.598e-4*x*x-0.003*x*y+0.273*y*y

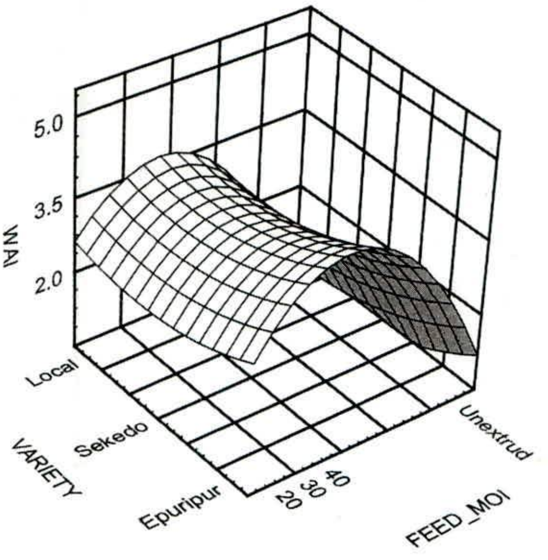
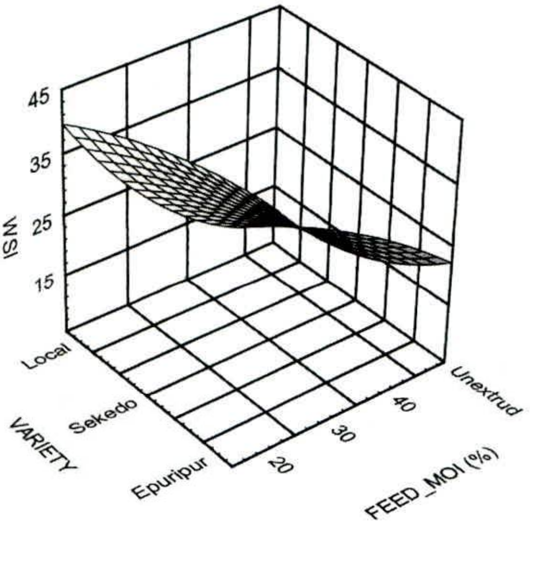


Figure 4. effect of feed moisture and variety on WSI z=25798.384+8.601*x-509.746*y-0.007*x*x-0.088*x*y+2.522*



As a matter of fact, smaller units acruing from such degradation are likely to be more accessible to the digestive enzymes than the large ones in samples that had experienced less dextrinization.

Of all the input factors, only feed moisture significantly affected the WAI and WSI (Table 2, Fig. 3 and FIg. 4). WSI decreased with increasing feed moisture. This was also observed by Badrie and Mellowes (1991) and Valle et al., (1994) for cassava and pea flour, respectively. They observed an increase in WSI with decreasing moisture content and increasing screw speed. A higher WSI is nutritionally preferred since the starch will be easier to digest.

Conclusion and recommendations

Subject to further studies to find ways of improving the micronutrients levels, it is possible to make nutritionally and functionally acceptable weaning foods from sorghum an un derutilized food crop grown in the country. The use of soybean as a high quality protein source and extrusion cooking technology would go a long way into helping in this endeavor. During extrusion, the best product from the raw materials used, is at lower feed moisture.

As far as weaning foods are concerned, Epuripur performs better than Sekedo and the varieies available on the local market.

Since this study did not cover the optimization of the micro-nutrients which are also very important in weaning foods, it is recommended that work should be done to address this aspect.

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