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Investigation on the Effect of Incorporating Germination in Processing of Mixed Food

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Abstract The study was designed to investigate the effect of incorporating germination as a unit operation in the processing of a cereal/legume mixed food, based on maize (Zea-mays) and cowpea (Vigna unguiculata). The grains were germinated and processed separately with either drum-drying or freeze-drying and the dried materials were mixed in little ratio. Parameters studied included proximate chemical analysis, total amino-acid profile, fluoro-di-nitro-benze (FDNB)-available lysine, digestibility, essential amino acid index (EAAI), biological value, and trypsin inhibitory activity and oligosaccharide composition of the cowpea. The physical qualities measured involved determination of water hydration capacity and amylographic studies of the properties of the maize. Germination and processing had little or no effect on the chemical properties of maize, except on digestibility, which was improved on germination. With cowpea, on the other hand, the available (FDNB) lysine and digestibility were greatly improved. There were also increases in protein and essential amino-acid contents during sprouting and processing. The trypsin inhibitory activity and the oligosaccharides of cowpea were significantly reduced by germination and processing. The water capacity of the processed grains was also improved.

Keywords Germination, Trypsin Inhibitor, FDNB-Available Lysine, Essential Amino Acids, Biological Value, Oligosaccharides, and Essential Amino Acid Index

1. Introduction

In developing countries, cost plays a large role in the kind of food consumed, and animal protein is beyond the economic means of many people. It is therefore important to develop processed foods that uses local, inexpensive materials, such as grain crops. Cereal/legume mixtures may be expected to provide the basis for cheap and palatable foods of high nutritional value.

Maize is readily available locally in commercial quantities and is already being used as a weaning food for children in the lower socio-economic groups of the third world, and particularly in Nigeria. Cowpea (Vigna unguiculata) is a legume which is high in protein, relatively inexpensive and is consumed in various ways in Nigeria and other Africa countries. It may be cooked with maize and eaten with meat or fish stew. It is often used in the preparation of Nigerian traditional dishes called 'moinmoin' or 'akara'.

Both components are deficient in one or two of the essential amino-acid. Maize, like other cereals, is deficient in lysine and trypsin, while cowpea is high in these amino-acids. Cowpea is deficient in S-containing amino-acids, which are reasonably abundant in maize.

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Germination is widely claimed as a means of correcting nutrient deficiencies in seeds especially through alterations in the amino acid balance of the proteins and enhancement of vitamin content, (1,2,3,19.)This project is therefore aimed at studying the feasibility of incorporating germination as a unit operation in the processing of a mixed maize/cowpea food.

2. Materials and Methods

2.1. The Germination Process

Germination of the grains was carried out using the jar methods of Chen (4) and assessment was carried out on the raw grains and after 2,3 and 5 days of germination at 25℃.

Early experiments with raw and germinated grains indicated that there was a progressive overall loss of protein during germination and germination was therefore limited to 2 days

2.2. Processing

Maize grains (germinated and germinated)were wet milled sieved and dried (using either a drum dryer or spray dryer). Cowpea was soaked ,cooked under pressure and dried similarly to the maize. Corresponding lots of maize and Cowpea were mixed in 1:1 ratio for assessment.

2.3. Chemical Assessment

Moisture determination was carried out using the AOAC (5) procedure, and Crude Protein by the routine procedure for total nitrogen determination of Marshall and Walker (6) Amino Acid analysis was carried out by automatic ion-exchange column chromatography based on the method of Spackman et al(7) using a JEOL,amino acid analyzer (Type JLC 5AH,Japan Electron Optics Co Ltd Tokyo) Flouridinitrobenzene (FNDB)-reactive lysine determination was estimated as described by Carpenter (8) and modified by Booth (9). Trypsin inhibitor activity of Cowpea was determined using a method based on that described by Kakade et al .(10) and components oligosaccharide (Raffinose and Stachyose) of raw ,germinated and processed cowpea grains were determined by HPLC (11). In- vitro digestibility was measured by the methods of Saunders et al (12), and essential amino acid index (EAAI) was calculated according to the method of Oser (13). The pasting characteristic of the processed maize were measured by using the Amylograph (14), and water hydration capacity was measured by the method of Quinn and Paton. (15)

3. Results and Discussions

As shown in Table 1,the percentage available lysine of 2-day sprouts of maize was increased by about 20% compared to that of raw maize; however when the overall loss of dry matter during the germination is taken into consideration the amount of available lysine is not increased.This may account for much of the confussion in the literature on the effect of germination on the protein effect of germination on the protein quality of cereal grains,since in general overall loss of dry matter has not previously been taken into account.(16,17,18,19,21.)

Table 1. Effect of germination on the FDBN-lysine, EAAI, Protein digestibility ,Dry matter loss and Crude Protein content of maize

SPROUT PERIODS (days)	FDBN Lysine (g/16gN)	EAAI (%)	PROTEIN DIGESTIBILITY (%)	LOSS IN DRY MATTER (%)	CRUDE PROTEIN (%)
0	2.5	63.2	84.4	-	9.1
2	2.9	58.1	89.9	11.1	9.0
3	2.5	61.1	92.2	14.4	9.4
5	2.9	63.4	93.4	15.8	9.5

Table 2. Effect of germination on FDNB-lysine, essential amino acids index (EAAI).protein digestibility,trypsin inhibitors activity ,oligosaccharides (stacyhose+ raffinose),dry matter loss and crude protein content of Cowpea

SPROUT	FDNB Lysine (g/16gN)	EAAI (%)	PROTEIN DIGESTIBILITY (%)	LOSS IN DRY MATTER (%)	CRUDE PROTEIN (%)	TRYPSIN INHIBITOR (%)	OLIGO-SACCHARIDE (%)
0	3.2	70.0	65.5	-	25.5	1875	6.7
2	5.1	71.7	90.0	17.9	21.7	785	Nill
3	5.4	70.5	91.6	19.9	28.7	720	Nill
5	6.2	62.3	94.6	23.1	27.5	435	Nill

Cowpea, (Table 2) showed some improvement on the nutritive value as a result of sprouting, and the increase in available lysine in particular ,there was still an increase after loss in dry matter had been taken into account

Table 3. Effect of processing and germination on FDNB-lysine, EAAI, Protein digestibility ,Dry matter loss and crude protein content of maize

Sample	Fdnb Lysine (G /16gN)	Eaai (%)	Protein Digestibility (%)	Loss In Dry Matter (%)	Crude Protein (%)
RAW	2.5	63.2	84.4	-	9.1
SPROUTED	2.9	58.1	89.9	11.1	9.0
DD-RAW	2.0	64.6	90.3	35.0	9.7
DD-SPROUTED	2.1	61.0	91.7	49.5	9.0
FD-RAW	2.0	60.3	92.9	33.9	9.0
FD-SPROUT	2.0	62.4	93.1	49.7	9.5

Table 4. Effect of processing and germination on FNDB-lysine ,essential amino acid index (EAAI),protein digestibility ,trypsin inhibitor activity, oligosaccharide (stachyose+ raffinose),dry matter loss, and crude protein content of Cowpea

Sample	Fdbn Lysine (G/16gn)	Eaai (%)	Protein Digestibility (%)	Loss In Dry Matter (%)	Crude Protein (%)	Trypsin Inhibitor (Tui/G)	Oligo-Saccharide (%)
RAW	3.2	70.0	65.5	-	25.0	1875	6.7
SPROUTED	5.1	71.7	90.0	17.9	21.7	785	Nill
DD-RAW	5.8	70.7	92.5	29.7	24.0	210	2.0
DD-SPROUTED	6.0	68.2	95.2	46.5	26.6	100	Nill
FD-RAW	5.7	69.3	95.6	28.8	24.7	375	1.9
FD-SPROUTED	6.4	68.2	97.2	48.3	24.7	180	Nill

DD=Drum- Dried; FD=Freeze- Dried

Table 5. Changes in approximate Water hydration capacity of Maize and Cowpea during processing

SAMPLE	RAW DRUM DRIED	SPROUTED DRUM DRIED	RAW FREEZE DRIED	SPROUTED FREEZE DRIED
Maize	3.7	4.0	1.2	1.3
Cowpea	2.9	3.1	1.6	1.7

Table 6. Effect of Processing on Amylograph data of Maize

MAIZE SAMPLE	TRANSISTION TEMPERATURE ℃	PASTETEMP AT MAXIMUM ℃	MAXIMUM VISCOSITY (BU)	15 MIN PEAK HEIGHT(BU)	SET BACK HEIGHT (BU)
Raw	83.0	No peak	No Peak	200	360
DD-Raw	51.8	71.0	690	360	460
DD-Sprouted	58.0	82.0	750	350	580
FD-Raw	69.0	77.0	950	270	180
FD-Sprouted	70.3	78.0	980	300	200

DD=Drum-Dried; FD=Freeze Dried

Germination and processing did not improve the nutritional quality of maize (Table 3) and when the overall loss of dry matter during germination and processing is taken into consideration, there is simply an overall loss of nutrient material, The only advantage were in water hydration capacity and in cooking quality as evidence by the Amylograph results (Table 5 and 6).

With Cowpea (Table 4) there were some advantages to balance the loss in dry matter .Available lysine and digestibility were both increased sufficiently to balance or exceed the dry matter loss.The elimination of flatulence –causing oligosaccharide and the very marked reduction in trypsin inhibitory activity are also important advantages.

4. Conclussions

Germination studies with maize and cowpea showed that although the protein content of cowpea was increased, this was accompanied by a loss in dry matter ,loss which although mainly carbohydrate, also included proteins. This loss is by no mean negligible, and where ignored has led to much greater claims for improvement in nutritional value following germination that can really be justified.

Processing led to further losses in dry matter, comparable to those experienced in the traditional 'ogi'(a fermented maize mash) ,and possibly in large part recoverable for use as animal feed if the process is operated on the industrial scale, of the order of 30%.

In the final analysis ,although no comparable advantages accrue from germination of maize in terms of nutrient content to balance the high losses in total dry matter ,with cowpea ,germination improves lysine availability, destroy s flatulence factors and trypsin inhibitory activities and also improves the digestibility of the protein sufficiently to outweighs the overall nutrient losses as a result of germination and processing

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