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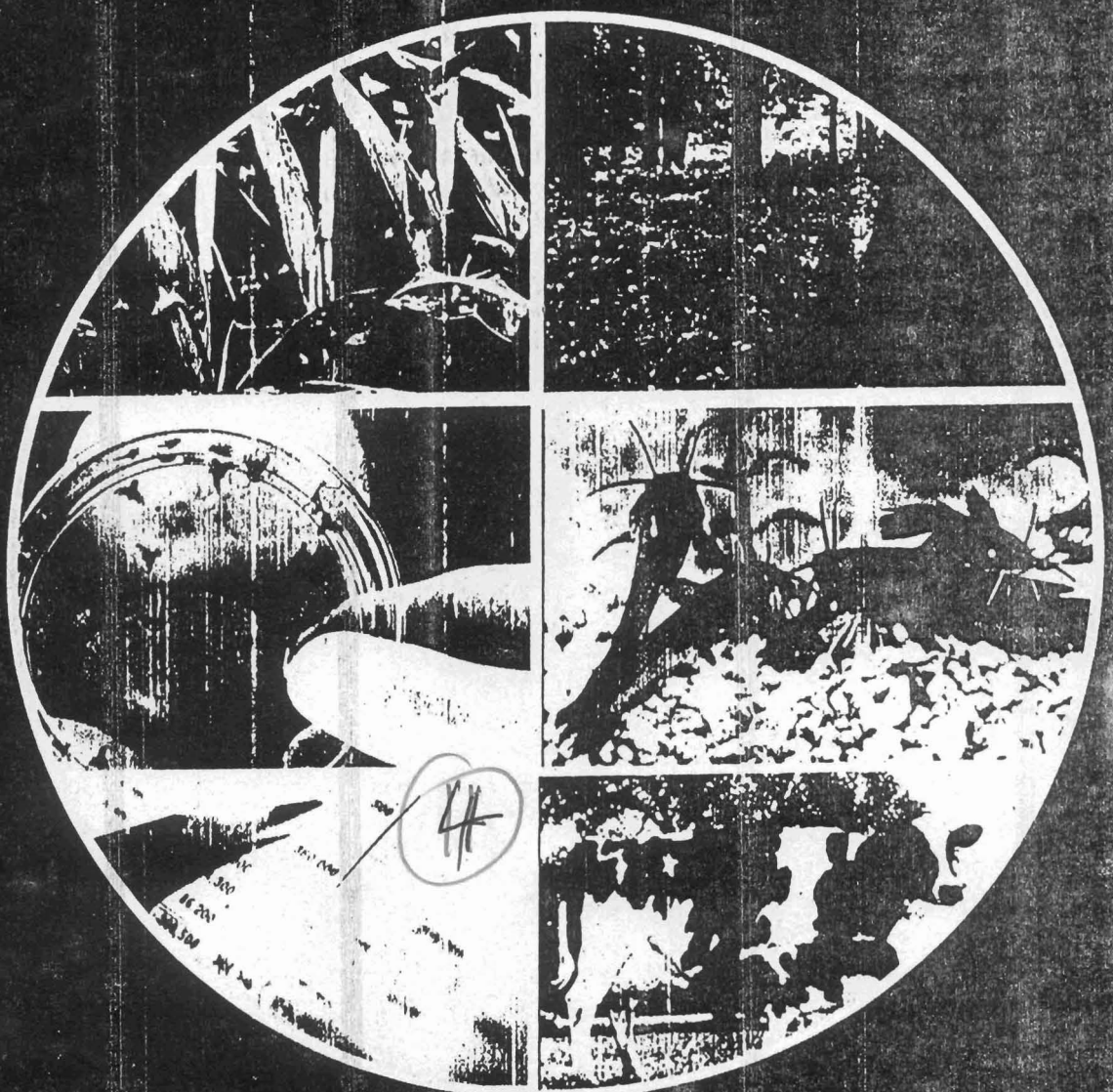

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EFFECT OF DIFFERENT DRYING TIMES ON THE PROXIMATE COMPOSITION OF HYDRATED SOYBEAN

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Abstract. This study investigated the relationship between the drying time and the nutrient content of hydrated soybean during drying in the process of converting it into flour. Boiling and oven drying method was used to prepare ten samples from Ibadan-2000 1485 – 1D at different drying times, ranging from 30 minutes to 5hrs. The results of the study showed that the protein, fat, ash and fibre contents decreased with increasing drying times while carbohydrate increased. The range was 55.02 to 41.71% for protein; 24.03 to18.91% for fat; 8.04 to 6.03% for Ash; 8.07 to 6.03% for Fibre and 4.56 to 27.31% for Carbohydrate at drying times of 30 and 300 minutes respectively for all. A strong negative linear and quadratic relationship was observed between protein, fat, ash and fibre contents and drying time. The results show that drying for a long period to achieve safe moisture content; will defeat the purpose of using soy flour as supplement due to a significant reduction in the protein content. Controlled drying conditions for a short period as being investigated is therefore recommended.
Key words: Hydrated soybean, chemical composition, drying time.

Introduction

Protein malnutrition is a major public health problem in some parts of the world, including Nigeria and the West African sub region (Anon, 2003). This is because diets in these areas are predominantly starchy, the major crops being roots, tubers and cereals. People, adult and children alike from low-income group do not feed on meat, eggs or fish because of socio-economic factors, taboos and ignorance (Nnanyelugo, 1985), whereas the high-income groups do (Cherian, 1981). This observation necessitates the need for affordable and acceptable plant protein sources. Soybean a cheap and locally available crop is known to have high protein content. The seed is easily processed into different products making it attractive to consumer. It is usually employed in protein supplementation of starchy foods. (Collins and Falasinu, 1977). There has been considerable interest in the nature, utilisation and advantages of soybean and its derivatives (Sanchez et al, 1995; Ruiz et al., 1995; Tezuka et.al., 1995; Dashell, 1987; Kolavalli et al., 1987). Similar interest has been shown on the improvement of the nutritional quality of some local foods such as *ogi, gari, fufu* and maize flour through legume-based supplementation (Muller, 1988; Alnwick *et. al*, 1988; Nkama, 1991). These factors contribute to the extensive utilisation of soybean and its derivatives in a wide range of domestic and industrial products.

The most convenient and functional means of traditional processing of soybean is through dehydration. It is generally acceptable when converted to flour from which the other forms of products are prepared. The conversion to flour and the accompanying heat treatments are necessary because some factors such as the beany flavour, long processing time and difficulty in cooking the raw bean makes it unpopular. Processing with thermal pre treatment, soaking and conversion into flour or wet slurry removes the unfavourable factors and makes it more acceptable to consumers. Hence, there is the need to evaluate the interdependence of nutrient composition and rate of drying. This is expected to help in product formulation and would
go a long way in ensuring that the desired nutrient is not lost through indiscriminate drying temperature and time. The objective of this study was to evaluate the effect of different drying times on the chemical composition of locally available cultivars of soybeans.

Materials and Methods

The soybean sample used, Ibadan-2000 1485 – 1D, was obtained from the International Institute of Tropical Agriculture, Ibadan, Nigeria. Soybean was weighed, winnowed, sorted and hydrated (ratio 1:8) in 0.2% $NaHCO_3$ for 6 hours at room temperature. It was then drained, dehulled and parboiled (1:8; 100° C, 30 mins) (Muller, 1988). Thereafter, it was cooled and dried over a period of five hours (300 minutes) in Stuart Scientific Oven set at 60° C (preliminary investigations show that drying at about 60° C gave the best nutrient density and physical acceptability). Samples were collected at 30 minutes drying time intervals, labelled, and subjected to proximate analysis for the changes in the chemical composition after drying (AOAC, 1990).

The statistical significance of the observed differences among the means of triplicate readings of

experimental results obtained were evaluated by analysis of variance (ANOVA), while means were separated using Duncan's Multiple Range Test. The results were also subjected to correlation and regression analyses. These analyses were carried out using Genstat 6.1 computer program (Genstat, 2002).

Results and Discussion

The chemical composition of soybean samples subjected to different drying times at 60° C is presented in Table 1. The protein, fat, ash and fibre contents follow the same pattern decreasing with increasing drying times. The carbohydrate on the other hand, increases with increasing drying times. This increase appears to be apparent, since all the other parameters are decreasing. The protein content ranged from 41.71 (300 minutes) to 55.02% (30 minutes); fat from 18.91 (300 minutes) to 24.03% (30 minutes); ash from 6.03 (300 minutes) to 8.04 (30 minutes) and fibre from 6.03 (300 minutes) to 8.07 (30 minutes). The observed decrease was significant ($P < 0.05$) for the four parameters.

The most pronounced decrease was recorded in the fibre and ash contents (25% each), closely followed by protein (24.19%) and fat (21.31%). This observation tend to suggest that increasing drying time at 60° C leads to considerable decrease in the nutrient density of soybean. This is a disadvantage especially when the decrease in protein and fibre are taken into consideration. The decreasing fat may be a benefit if it has not gone below the acceptable limit.

Table 1: Proximate composition (% moisture free basis) of hydrated soybeans subjected to different drying times at 60° C

Drying time (min)	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	Carbohydrate (%)
30.00	55.02 ± 0.01i	24.03 ± 0.02g	8.04 ± 0.02h	8.07 ± 0.04g	4.56 ± 0.02a
60.00	53.51 ± 0.06h	23.92 ± 0.03g	7.82 ± 0.02g	7.83 ± 0.06f	6.92 ± 0.06b
90.00	49.40 ± 0.23g	22.45 ± 0.03f	7.42 ± 0.04f	7.45 ± 0.06e	13.27 ± 0.04c
120.00	49.25 ± 0.14g	22.57 ± 0.06f	7.22 ± 0.03e	7.23 ± 0.13e	13.78 0.06d
150.00	47.79 ± 0.06f	22.07 ± 0.12e	7.00 ± 0.12d	6.97 ± 0.06d	16.26 ± 0.15e
180.00	46.38 ± 0.05e	21.14 ± 0.08d	6.78 ± 0.05c	6.80 ± 0.06cd	18.90 ± 0.03f
210.00	45.52 ± 0.06d	21.25 ± 0.14d	6.63 ± 0.03c	6.65 ± 0.05c	19.94 ± 0.03g
240.00	43.97 ± 0.04c	20.44 ± 0.13	6.36 ± 0.03c	6.39 ± 0.05b	23.07 ± 0.04h
270.00	42.74 ± 0.02b	19.62 ± 0.04b	6.20 ± 0.12ab	6.24 ± 0.14ab	25.21 ± 0.12i
300.00	41.71 ± 0.03a	18.91 ± 0.04a	6.03 ± 0.17a	6.06 ± 0.04a	27.31 ± 0.03j

Values are means of three replicates

Values in a column denoted by different letters differ significantly at $P < 0.05$

The decrease in the ash content may be due to the decrease in moisture accompanying increased drying times. Ash content is a measure of water soluble minerals present in a food material (Pearson, 1976). The observation with fibre suggests that the fibrous portion of soybean is sensitive to heat, leading to breakdown into simpler, non-fibrous forms, thereby leading to reduction (Ogundipe, 1989). Denaturation may be responsible for the decrease in the protein content obtained with increasing drying time at 60° C. From a technological point of view, there exists a 'conflict of interests' between the anti-nutritional compounds which can only be destroyed by vigorous heat treatment and the functional properties of proteins which require gentle treatment (or none at all) if they are not to be denatured (Alais and Linden, 1999). Furthermore, proteins (amino acids) would react with carbohydrate (reducing sugar) in the food matrix (Maillard reaction), in the presence of heat, leading to the formation of melanoidins (Baltes, 1982). The formation of these compounds is desirable in the heating of many food products (meat, coffee, bread) but their occurrence during processing and storage of other products is undesirable and leads to a reduction in quality.

The main fatty acids in soy oil, linoleic acid (50%) and oleic acid (35%), are highly unsaturated, hence are more susceptible to oxidative breakdown (causing the appearance of rancid flavour during storage of soya). Metals, particularly copper and iron, have been known to catalyse the oxidative breakdown of fats to carbonyl groups with α and β double bonds (Alais and Linden, 1999). In the presence of heat, this process is hastened and could be responsible for the decrease in fat content with increasing drying time at 60° C. The behaviour of the parameters measured in response to increasing drying times can be described using both linear and quadratic regression equations

shown in Table 2. On the basis of these equations, the interdependence of each of the parameters measured can be completely described and predicted over wider drying times at 60° C.

Table 2: Regression analysis with equations relating proximate composition and drying times of hydrated soybeans at 60° C.

Parameters	Model	R^2	a	b	c
Protein	LIN	0.964	55.3600	-0.0475	
Protein	QUA	0.979	56.9033	-0.0732	7.8E-05
Fat	LIN	0.963	24.6776	-0.0184	
Fat	QUA	0.965	24.4720	-0.0150	-1.0E-05
Ash	LIN	0.973	8.1740	-0.0074	
Ash	QUA	0.980	8.3415	-0.0102	8.5E-06
Fibre	LIN	0.959	8.1833	-0.0074	
Fibre	QUA	0.969	8.3792	-0.0106	9.9E-06
Carbohydrate	LIN	0.976	3.4927	0.0814	
Carbohydrate	QUA	0.984	1.6027	0.1129	-1.0E-04

LIN = Linear model: $y = ax + b$; QUA = Quadratic model: $y = ax^2 + bx + c$

Where y = % composition of parameters measured; x = drying time at 60° C

The high R^2 value associated with both models show that a strong relationship exists (Oloyo, 1999) between drying time and each of the parameters measured. Thus, the equation $y = -0.0475x + 55.36$, $y = -0.0184x + 24.6776$, $y = -0.0074x + 8.174$, $y = -0.0074x + 8.1833$ and $y = 0.0814x + 3.4927$, describes the linear relationship between the protein, fat, ash, fibre and carbohydrate contents (*y axis*) respectively and drying time (*x axis*) when dried at 60° C. The use to which the soybean will be put and the desired protein content would determine the duration of the drying time employed. This can be easily predicted using the equations in Table 2.

Reliability analysis results using the alpha scale (a model of internal consistency), presented in Table 3 indicates a strong negative relationship between drying time and the parameters measured (except carbohydrates). Reliability analysis makes it easier to study the properties of measurement scales and the items that make them up. Thus, it provides information about the relationships between individual items in the scale, determines the extents to which the items measured are related to each other, gives an overall index of the repeatability or internal consistency of the measurement as a whole, and identify problem items that should be excluded from the scale (SPSS, 1999). The result of the reliability analyses is consistent with the data obtained in Table 1 and complements that in Table 2.

Table 3: Interdependence of drying time with proximate composition of hydrated soybean subjected to different drying times at 60° C from Reliability analyses (alpha scale).

	DT	PROTEIN	FAT	ASH	FIBRE	CHO
DT	1.0000					
PROTEIN	-0.9821	1.0000				
FAT	-0.9814	0.9808	1.0000			
ASH	-0.9863	0.9872	0.9757	1.0000		
FIBRE	-0.9793	0.9814	0.9644	0.9711	1.0000	
CHO	0.9879	-0.9984	-0.9857	-0.9880	-0.9810	1.0000

DT: Drying Time

CHO: Carbohydrate

Conclusion

This work has shown that drying time has notable effect on the chemical composition of soybean. The observed behaviour was fully described using linear and quadratic regression equations. Given the need to use soybean as a substitute, processing the bean to other products requires retaining the nutritional constituents, so as not to defeat the aim of the supplement. The need to

dry the product to a safe level of moisture content usually led processor to drying for a long period. However, this as found out, need to be discouraged and the use of controlled drying environment, which will hasten the rate of drying is recommended.

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