Storage stability and nutrient content of whole maize meal and degermed maize meal

ABIGAIL ANDAH
Food Research Institute, P.O. Box M.20, Accra, Ghana

SUMMARY

Two types of maize meal, dried to a moisture level of 8·0% to forestall mould growth, were placed in airtight containers and stored at room temperature (27°C) for 3 months. Fat acidity value of the whole meal was more than double its original value (from 34·72 mg KOH/100 g to 78·76 mg KOH/100 g) after 2 weeks storage, and at this stage, taste panel results on cooked samples showed development of off-flavour and bitterness. After 12 weeks storage, the fat acidity value of the whole meal was 246·43 mg KOH/100 g. On the other hand, the initial fat acidity value of the degermed meal, 12·11 mg KOH/100 g, increased to only 36·28 mg KOH/100 g after 12 weeks storage and no odours were detected when cooked samples were tasted. These results showed that development of off-flavours and after-taste due to fat rancidity was much faster in the whole maize meal than was found in the degermed maize meal. Analyses for nutrient content showed that thiamine, riboflavin, iron and phosphorus were significantly reduced by degermination whilst the protein content was only slightly reduced.

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RÉSUMÉ

ANDAH, ABIGAIL: *Stabilité et valeurs nutritives comparées des farines de mais entier et de mais dégermé, au cours de la conservation.* Les deux types de farine de maïs (entier ou dégermé), ramenées à 8% d'humidité, de manière à éviter le développement de moisissures, ont été placées dans des vases hermétiquement clos et conservées à la température ambiante (27°C) pendant 3 mois. L'acidité des acides gras de la farine de maïs entier a plus que doublé sa valeur d'origine (de 34,72 mg KOH/100 g à 78,76 mg KOH/100 g) après 2 semaines de conservation et à ce stade, le tableau des essais organoleptiques d'échantillons cuits a révélé un développement d'odeurs anormales et d'amertume. Après 12 semaines de conservation, l'acidité des acides gras de la farine de mais entier était de 246,43 mg KOH/100 g Par ailleurs, la valeur d'origine de l'acidité des acides gras de la farine de mais dégermé, 12,11 mg KOH/100 g, s'est élevée seulement à 36,28 mg KOH/100 g après 12 semaines de conservation et aucune odeur n'a été observée quand des échantillons cuits ont été essayés. Ces résultats montrent que le développement d'odeurs anormales et d'arrière goûts dus au rancissement a été beaucoup plus rapide dans la farine de mais entier qu'il n'a été observé dans la farine de mais dégermé. Des analyses des constituants nutritifs ont mis en évidence que la thiamine, la riboflavine, le fer et le phosphore ont été réduits de manière probante par la dégermination du mais, tandis que la teneur en proteine n'a été que légèrement diminuée.

Introduction

In both grain and grain flours, fat acidity is considered very important because it is generally used as a measure of deterioration (Matz, 1959).

Various workers have investigated factors that influence the stability of grains and grain flours on storage, and a relationship was found between fat acidity values and the degree and type of damage to the grain (Baker, Neustadt & Zeleny (1957); Sorger-Domenigg, Cuendet & Geddes (1955)). Other work in this field showed that whole-wheat flour stored at low moisture content and temperature developed odours faster than patent flour. The stability of flours may be enhanced by increasing the degree of refinement and decreasing moisture content below normal commercial levels (Cuendet *et al.*, 1954). By keeping moisture content low, mould growth which contributes significantly to the development of odours is controlled.

Increasing the degree of refinement in flour ensures elimination of as much of the germ portion of the grain as possible, thus ensuring the removal

of most of the oil which is found mainly in the germ. Fats when present in cereal flours may be split up enzymatically by lipase to liberate fatty acids which may impart bitterness to the product or they may undergo oxidation with the production of an unpleasant tallowy state. Both types of fat deterioration occurs in flours of cereals, so milling engineers have designed milling equipment in a way to exclude from white flour as much fat or oil as possible (Kent-Jones & Amos, 1967).

Natural nutrients in whole meal are significantly higher than in degermed meal. This is because these nutrients occur mostly in the germ, aleurone layer and scutellum tissue of the grain which are removed in the dry milling process of degermination (Inglett, 1970).

During the last year, there have been calls from governmental levels to the Ghanaian bakers to go into production of bread made from composite flour as a means of cutting down importation of wheat and thereby saving foreign exchange. In the manufacture of corn bread, maize flour is used to replace part of the wheat flour but there is no mill in Ghana producing maize flour for such purpose. As a result, the few bakers engaged in corn bread manufacture have been using maize meal which is prepared by the individual bakers.

The object of this work was to investigate the effect of storage on the stability of whole maize meal and degermed maize meal using fat acidity values and a taste panel, as a measure of deterioration. The effect of degermination on nutrients was also investigated.

Materials and methods

Maize meal

Three samples each of whole maize meal and degermed maize meal samples were prepared with an attrition mill from white local maize. The moisture levels of the meals were kept at 8% and the samples were stored in air-tight containers at room temperature. The proximate composition of the meals was determined according to methods of A.A.C.C. (1962).

Fat acidity of maize meals

The fat acidity values were determined at intervals of 1 week using A.A.C.C. method 021-01. Analysis of each sample was carried out in duplicate. It is recommended that all samples should be at moisture level not above 10% in order to secure comparable results, otherwise, hydrolysis at time of extraction increases the fat acidity values.

Thiamine and riboflavin contents

The thiamine content was determined by the thiochrome method (A.A.C.C., 1962). For the determination of riboflavin, the fluorimetric method was used (A.A.C.C., 1962). A Hilger & Watts Fluorimeter Type H960 was used for both determinations.

Mineral contents

Calcium was determined by the standard method as described by A.O.A.C. (1970). Phosphorus was determined according to the method as described by Fogg & Wilkinson (1958). Iron was determined by the method described by A.O.A.C. (1970).

Taste panel

At intervals of 1 week samples were cooked for tasting. Each sample (20 g) was soaked in 200 cm^3 water for 2 h. The mixture was cooked with stirring till boiling. It was then boiled for 10 min. The cooked samples were then tasted by a panel of six to detect any off-flavour and after-taste. Using the paired comparison difference analysis (Lamond, 1967), each sample was presented to a panelist four times labelled A, B, C & D, and was compared to a fresh (unstored) cooked sample R. This made a total of 24 judgements on each sample.

Results and discussion

Changes in fat acidity

The initial value of fat acidity for degermed meal was much lower than that for the whole meal as a result of the elimination of maize oil from the grain in the course of degermination. The rate of development of free fatty acids during the storage period was much higher in the whole meal than in the degermed meal as illustrated in Fig. 1. This may be due to enzymatic breakdown or oxidation of maize oil in the whole meal or both (Kent-Jones & Amos, 1967).

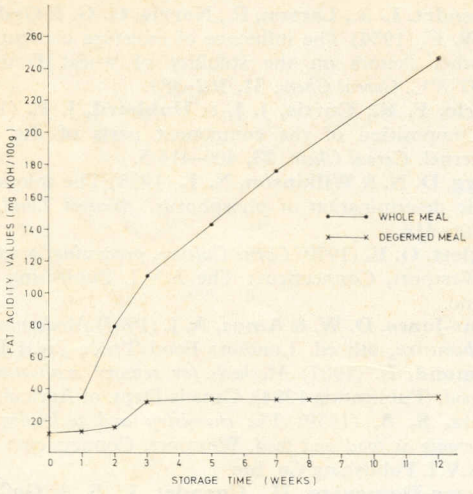

Fig. 1. Rate of free fatty acid production in stored maize meals (dry weight basis).

TABLE 1

Nutrient Content of Whole and Degermed Maize Meals (Dry weight basis)

Constituent	*Whole maize meal*	*Degermed maize meal*
Crude protein (%) (Nx 6·25)	10·2	9·6
Crude fibre (%)	2·9	0·5
Ether extract (%)	4·3	0·1
Ash (%)	1·2	0·1
Thiamine (g/g)	4·36	0·21
Riboflavin (g/g)	0·44	Nil
Iron (mg/100 g)	5·1	3·1
Calcium (mg/100 g)	24·6	8·2
Phosphorus (mg/100 g)	343·2	86·9

Nutrient changes

Mineral content of whole maize meal showed high levels of iron, calcium and phosphorus (Table 1).

There was a reduction of mineral content after degermination. This is because about 80% of the minerals are in the germ (Earle, Curtis & Hubbard, 1946). The results on thiamine and riboflavin content showed that whole maize meal was initially deficient in riboflavin which was further reduced by degermination. Thiamine which was quite high was drastically reduced by degermination. This is due to the fact that both vitamins are concentrated in the germ part of the maize grain.

Taste panel

Taste panel results showed that after 2 weeks storage, whole maize meal developed off-flavour and bitter after-taste whilst the flavour and taste of degermed meal was acceptable up to 12 weeks storage (Table 2). Even though there was some increase in level of free fatty acids in degermed maize meal, as shown in Fig. 1, it was not high enough to be detected by taste panel.

The results show that whilst degermination prolonged the shelf-life of maize meal, it also reduced its nutrient content.

Attempts by other workers to lengthen the shelf-life of whole maize meal by the use of heat or antioxidants have so far been unsuccessful (Inglett, 1970). Degermination, therefore, seems to be the most efficient way of prolonging the shelf-life of maize meal.

On the question of nutrient content, it is hoped that on the establishment of maize flour mill,

TABLE 2

Statistical Analysis of Taste Panel Scores of Stored Maize Meals (Paired Comparison Difference Test)

Product	*No. of observations*	*Mean score fresh sample*	*Mean score stored sample*	*Student's test*	*Probability*
Whole meal stored for 1 week	24	9	8·4	−0·402	NS
Whole meal stored for 2 weeks	24	9	2·1	±14·640	S
Degermed maize meal stored for 12 weeks	24	9	8·2	−0·186	NS

NS: Not Significant ($P=0·05$)
S: Significant ($P=0·05$)

appropriate enrichment of flour would be carried out.

It is recommended that whole maize meal be used within 7 days of preparation in order to forestall the development of off-flavour.

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