Effects of Process Variables (Soaking Time and Drying Temperature) on Proximate Composition of Oven Dried Maize (*Zea mays*) Pap

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K E Y W O R D S

Drying temperature,
Maize pap,
Optimization,
Proximate composition,
Soaking time,

A B S T R A C T

Effect of soaking time (30 - 70 h) and drying temperature (40-100°C) on proximate composition, of oven dried maize pap were studied. Powdered pap was produced from maize. Maize grain was cleaned and soaked in water at 60°C between 30 - 70 h and wet milled, sieved and oven dried between 40 - 100°C sieved to obtain pap powder which was subjected to proximate analysis. The moisture decreased with increase in soaking time. The protein content differed significantly ($p < 0.05$), with values that ranged from 9.58-13.70 %. Ash content differed significantly (0.68 - 1.00 %), The fat content differed significantly (8.35 - 9.91 %) The crude fibre differed significantly (0.36 - 0.12 %,) carbohydrate was significantly different (65.42 - 72.4 %,) These findings suggested that varying the soaking time and oven-drying temperature significantly affected the proximate composition of the dried maize pap (Akamu) powder. The optimum conditions that would give the best product in terms of proximate composition were soaking time (34 h) and oven drying temperature (46 ^{o}C).

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INTRODUCTION

According to Adeoye and Toyin (2013) and Bolaji *et al*. (2014), traditional methods of cpap production differed and different cultures and no standardized method has been established, hence it is imparative to establish specific method. The powdered form of pap is scarce for now. Time of soaking and temperature of drying have been identified as the major processing variables that could influence dried pap qaulities (Omemu, 2011; Adeoye *et al*., 2013) The longer the soaking time, the higher the acidity (TTA) of the pap. Some researchers reported a significant difference in the viscosity as the soaking time increased, while some reported that there was no significant difference (Bolaji *et al*., 2011; Bolaji *et al*., 2017) A lot of work had been done on the nutrirtional quality , storage, rheological properties of corn pap (gruel) but little or not much reports exists on the effects of process variables on the nutritionaly properties of the gruel (Esther *et al*. ,2013; Bolaji (2014; Wasiu *et al.,* 2016.) pap (*Ogi)* is normally used as weaning and breakfast food in Nigeria for infants and adults respectively (Esther *et al*. (2013) stated that long soaking time helps not just to soften the grains but also improves the product quality, but there are nutrients losses which are significant with the long soaking period. Many studies indicated that the seed-coat and germs are where the proteins are located and they tend to leach out during the long soaking period, the fibers vitamins and ashes are affected too and have been reported. Process variables are those physical or chemical parameters or quantities that influence processes we wish to control at correct limit. The drying temperature of the wet *ogi* to powder is an important factor (Bolaji *et al*., 2014a ; Bolaji *et al*., 2016). The effect of drying temperature has been reported to increase shelf life yet can destroy the heat sensitive nutrient (Esther *et al.*, 2013). Proximate composition is a term in food science or in the field of feed /food that means the six major components of foods; Moisture, Ash, Fat, Protein, Carbohydrate, and Fibre which are expressed as the percentage (%) in the feed, respectively (Awuchi, 2019a; Awuchi *et al.,* 201914; kajihausa *et al.,*2014).

Response surface methodology (RSM) is a collection of statistical design and numerical optimization techniques used to optimize process and product design. (Ishiwu *et al.,* 2014)

The aim of this study was to determine the effect of soaking time with drying temperature on the proximate composition of powdered pap (*ogi*) from maize (*Zea mays*)

MATERIALS AND METHODS

Source of raw materials

The yellow maize (zea mays) variety was purchased from a local market, Eke- Awka in Awka south local government Area, Anambra state, Nigeria

Sample preparation

About 13 kg of the grain was divided into 13 parts with an equal weight of 1kg each. The maize was sorted, cleaned to remove extraneous materials and they were labeled accordingly and soaked differently with clean water at 60ºC, following the procedure in Table. The soaked grains were rinsed and wet-milled using attrition mill. The wet milled *ogi* was sieved using muslin cloth and a measured quantity of water (4 L) and allow to sediment for 20 min before decantation. The recovered slurry was transferred into a cloth bag and allowed to drain-off the water by expression. The drained *ogi* was weighed using a laboratory balance to get about 1 kg of each sample which was dried using oven at varying temperatures as shown in Table 1. The dried powdered *ogi* was dry-milled and sieved with standard mesh size (150 um), to obtain a fine powdered *ogi*, and was neatly packaged for proximate analysis

Experimental Design

The experimental design used was of Response surface methodology (RSM) designed in Face Centered Central Composite Design (FCCCD) with 2 independent variables (A and B as soaking time and drying temperature respectively). The design was carried out using a statistical package, Design Expert version 8.0.7.1. The levels of the process variables were established based on the some preliminary tests to arrive at Soaking time (30 – 70 h) and Drying temperature (40 -100 ºC).

Table 1: Experimental runs used in the processing of the oven dried powdered ogi.

Sample runs	soaking time (h)	Drying temperature (ºC)
1	70	70
2	50	70
3	50	70
4	30	100
5	70	40
6	70	100
7	50	70
8	50	70
9	50	70
10	50	100
11	30	40
12	30	70
13	50	40

Analyses

Proximate analysis

The proximate composition was determined using the hot oven method described by AOAC (2010)

Statistical analysis

Design Expert version 8.0.7.1 was used for the regression analysis and plotting of contour graphs

RESULTS AND DISCUSSION

The contour plot is for extrapolating soaking time and drying temperature. All in the box represents the protein content.

When the soaking time of 33 h and drying temperature of 55°C were increased to 58 h and 68°C, the protein content increased from 10 to 13%. This corroborated the report of Njintang *et al*. (2017) who reported that soaking time increased fermentation which positively may affect the value of soluble nutrients such as protein in a cereal product.

ANOVA for response surface quadratic model for fat showed that model was significant at 0.0001 levels, lack of fit is 0.0209 and R^2adj was 92.89%. These conditions qualified fat for modeling

Fat= $9.27+0.41A+0.37B-0.20B^2$ ……………… Eq. 1

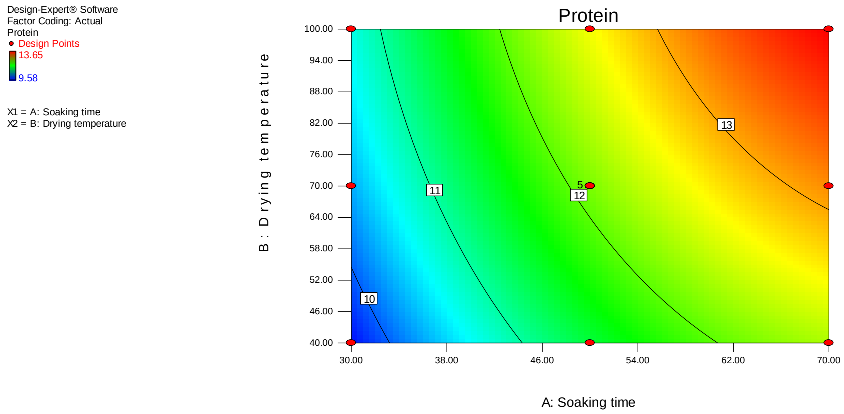

Fig. 1: Contour plot showing the effect of soaking time and drying temperature on the protein content of the *ogi* powder

From the contour plot , as the soaking time increased from about 40 to 63 h and drying temperature increased from 48 to 79 ^{o}C, the fat content increased from 8.5 to 9 %

ANOVA for response quadratic model for crude fibre showed that model for fiber was significant. Its R^2 adj was high (84.45%), Lack of fit (0.1840) was not significant.

Quadratic model was suggested as shown in Eq. 2

Fiber (%) = $0.19 - 0.078A + 0.33B + 0.047A^2$…………….. Eq. 2

It qualified the for fitting a response variable into a model which stated that the model has to be significant, the R^2adj. has to be high (≥60%), the lack of fit shouldn't be significant and the p-value to be included has to be significant ($p \leq 0.05$)

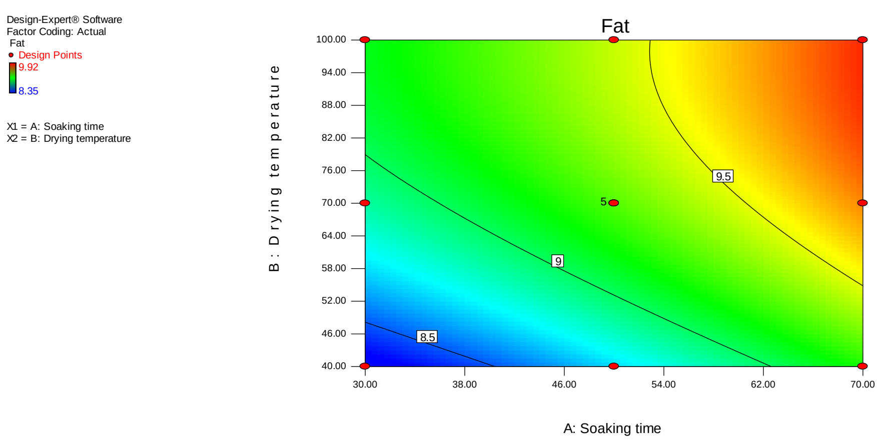

Fig. 2: Contour plot showing the effect of soaking time and drying temperature on fat content of the *ogi*

ANOVA for Response surface linear model for ash showed that the model was significant at p-value< 0.0001. The lack of fit was not significant at p = 0.2939, R^2adj = 90.3%

Crude fibre=$0.18 - 0.07A + 0.033B + 0.052A^2 + 6.552E\text{-}003B^2$ …………….. Eqn. 3

At soaking time of 33 h and drying temperature of 88°C, the crude fibre content was 0.35%, and decreased to 30 % when the soaking time increased to 36.5% at drying temperature of 64 ^{o}C. This showed that drying temperature had appreciable effect on the crude fibre content.

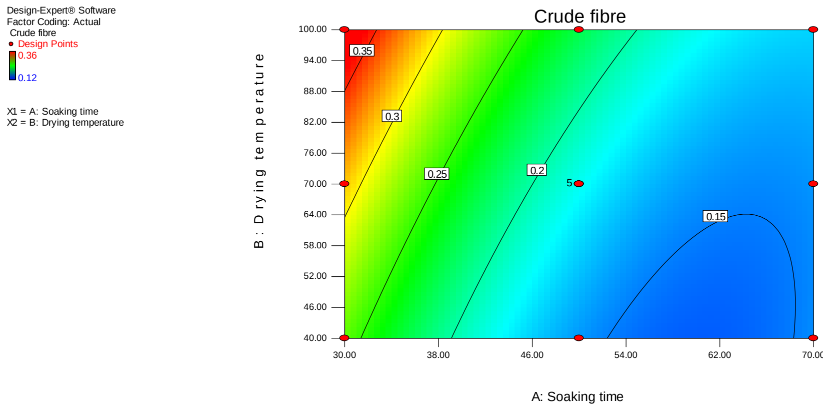

Fig. 3: Contour plot showing the effect of soaking time and drying time on the crude fibre content of the *ogi* powder.

ASH = 0.88+ 0.095A+ 0.065B …………… Eq. 4

It was seen that at the soaking time of 47 h and drying temperature of 77 °C, the ash content increased to 0.8%, while at soaking time of 63 h and drying temperature of 85°C, the ash content increased to 1 % respectively.

The effect of the process variables shows that Carbohydrate from the ogi was decreased with an increase in the soaking time but with drying temperature did not show much noticeable difference in the carbohydrate content.

The decrease in Carbohydrate could be as a result of high soaking time in which fermentation is induced, thereby leading to a reduction in the starch content.

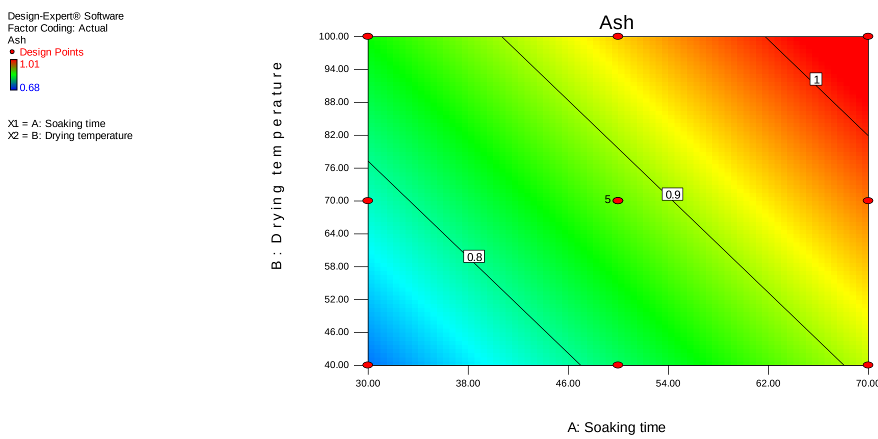

Fig. 4: Contour plot of the relationship between process variables and ash

The Figure 5 shows the predicted process variable values proximate parameter at desirability of 1.0 It shows that at soaking time of 34 h and drying temperature of 46°C, the optimized proximate composition of the ogi powder could be attained

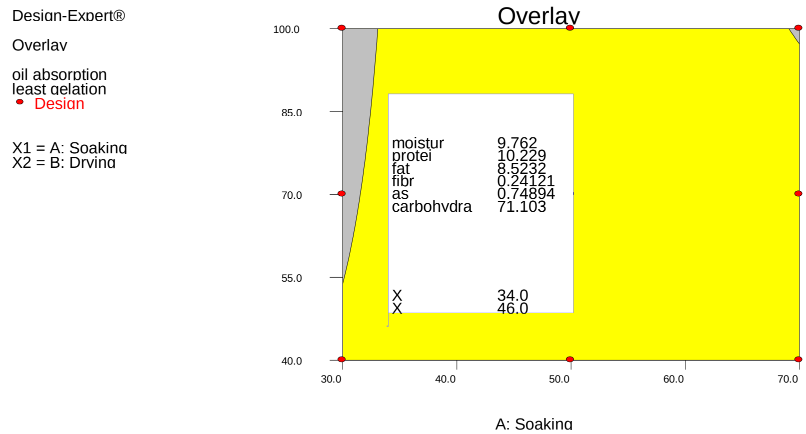

Fig. 5: Optimization plot of the proximate composition of the powdered pap

CONCLUSION

This study has revealed that soaking time and drying temperature could influence the proximate composition of oven dried maize pap (ogi)

RECOMMENDATIONS

Further studies should be carried out to investigate, the shelf stability of the oven dried pap, the nutrient density in relation to standard references and bioavailability of the important minerals

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