GLOBAL JOURNAL OF PURE AND APPLIED SCIENCES VOL. 6 NO. 4, SEPTEMBER 2000:589-592
 ISSN 1118-0579

PREDICTING THE EFFECT OF PARTICLE SIZE PROFILE, BLANCHING AND DRYING TEMPERATURE ON THE DISPERSIBILITY OF YAM FLOUR

E. A. UDENSI and J. C. OKAKA

(Received 25 August 1999; Revision accepted 15 May, 2000)

ABSTRACT

The effect of particle size, blanching and drying temperature on the dispersibility properties of yam flour was evaluated. Yam flour was processed by blanching for 0, 3, 6 and 9 minutes followed by drying at 60°c, 80°c. and 110°. The yam flours separated on sieves of 425nm, 180nm, 150nm and 75nm were studied in model systems. Regression analysis was used to fit data generated in the study to first order relationship to circumvent the problem of non-linearity of primary data. Blanching was found to affect more the dispersibility influencing properties such as water holding capacity, wettability and bulk than the drying temperature. The rate of dispersibility properties followed apparent first order kinetics and the rate constants correlated highly. The rate constants for the water holding capacity of the yam flours ranged from 7.40 to 8.90 (10^{-2} x min^{-1}); 2.07 to 2.50 (10^{-2} x min^{-1}), and 0.04 to 0.04 to 0.09 (10^{-2} x min $^{-1}$).The corresponding rate constants for wettability were 8.40 to – 12.80 (10^{-2}x min^{-1}); -8.06 to 12.58 (10^{-2} x min^{-1}); and–3.22 to –4.37 (10^{-2}x min^{-1}). Those for dispersibility were –10.82 to – 29.02 (10^{-2} x min^{-1}); -14.50 to 19.30 (10^{-2} x min^{-1}) and –10.82 to –29.02 (10^{-2} x min^{-1}). Results obtained after first order mathematical modeling showed high correlation (0.83 – 0.96) in nearly all cases between the independent and response variable. Thus, such mathematical manipulation of experimental responses may enhance the predictive potential of the data on the effect of processing conditions on the dispersibility of a particular variety of yam flour.

Key words: Predicting, particle size, Blanching, Drying temperature and Dispersibility of yam flour.

INTRODUCTION

With the increase in the use of powdered foods in Nigeria for different applications, there is the need to investigate the performance of particular powders in classical functional tests which include swelling ability, water absorption, wettability and dispersibility as a response to processing and handling parameters.

Data generated from measurements arising from these standard studies when subjected to mathematical modeling are likely to produce constants which can be used to make predictions of the behaviour of the food powder in specific food systems. No published information exists on the predictive effect of blanching, drying temperatures and particle size profile on the water absorption, wettability, bulk density and dispersibility of oven-dried yam flour and the manipulation of such data to test their efficiency in predicting best processing conditions for the powder.

This study has as its main objective, the production of yam flour by drying the corresponding raw material at different temperatures with or without blanching. Following this, the variously dried products were to be studied for the functional properties in relation to processing condition with a view to determining compatible processing regimens. Data collected are to be fitted to the first order curve (Y = A = BX) to determine if the constants associated with such curves have any predictive value for the powder system behaviour.

MATERIALS AND METHODS

PREPARATION OF YAM FLOURS:

Raw yams (***Dioscorea rotundata***) obtained from retail market in Abakaliki, Ebonyi State, Nigeria, were peeled, washed, sliced and blanched at 100°c for 0, 3, 6 and 9 minutes and oven-dried at 60°c, 70°c and 11°c to about 10 percent moisure content, The dried yam slices were ground with a disc attrition mill (locally fabricated) in four passes to produce yam flours. Samples of yam powder were sieved for 15 minutes on a Karl kolb, EM 200 sieve shaker fitted with sieves of apertures of 75, 150, 180 and 425nm. The different fractions of yam product obtained were packaged, labelled and stored in an air-tight can for this study.

BULK DENSITY

The method of Okaka and potter (1979) was adapted. Bulk densities were determined by weighing

E. A. UDENSI, School of Food Sc. & Tech. Abia State, University Umuahia Campus - Nigeria
J. C. OKAKA, Department of Food Sc. & Tech, Enugu State University of Science and Technology - Nigeria

3g of samples into 10m1 graduated cylinders and tapping ten times against the palm of hand. The volume of the powder after tapping was recorded and the bulk density was expressed as g/cm^3.

WATER HOLDING CAPACITY

This was determined by the method of Lin **et al**; (1974). Duplicate 1g samples of the flour were each mixed with 10cm^3 of distilled water and stirred for 1 minute with a glass rod in graduated centrifuge tubes.

The tubes were then held for 15 minutes at room temperature after which the suspensions were centufuged at 2500 x G for 15 minutes and the volume of the free water recorded. The mean of the amount of water retained by the duplicate samples of powder was recorded and formed the basis for calculating water absorption capacity.

WETTABILITY

The method of Armstrong et al. (1979) was adapted. Wettability was estimated by measuring the wetting time (***secs***) of 1g of the sample powder dropped from a height of 15mm on to the surface of 200cm^3 of distilled water contained in 250cm^5 at room temperature (°c). The Wetting time was regarded, as the time required for all the powder to become wetted and penetrate the surface of the still water.

DISPERSIBILITY:

The method described by ***Pisecky (1979)*** was adopted except that dispersed sample was filtered through a weighed piece of cheese cloth. A 3g sample of the powder was dissolved in 50m^3 of distilled water in beaker and stirred with a stirring rod for one minutes at room temperature (°c). The dispersion was then filtered through dried sieve cloth of known weight. Exactly 10cm^3 of distilled water was used to rinse the beaker and the beaker content poured through the cheese cloth.

The sieve cloth and the residue were dried in a hot air oven at 100°c for 10 minutes. The dispersibility was expressed as the percentage of the solids dissolved.

RESULTS AND DISCUSSION

BULK DENSITY:

The bulk density of the flour showed no definite trend. However, higher bulk densities were obtained for flours dried at 110°C (Table 1). The influence of the bulk density on sinkability influences the wettability of the flour particles. Generally, the higher the bulk density, the greater the ease ot dispersibility (***Breman et al., 1976***).

WETTABILITY

Although wettability is a property not easily distinguished from sinkability and it is difficult to measure accurately, an approximate determination of wettability which can be made rapidly, provides a useful indication of the degree to which a dried yam flour is likely to possess instant characteristics. The wettability of yam powder was evaluated by determining the wetting time. Blanching increased the wettability of yam flour (Table 2). This observation may be attributed to the role carbohydrate plays in food systems, Blanching at 100°c causes the gelatinization of starch which enhances starch-water interaction. Progressive heating causes greater loss of starch-network, thereby increasing the degree of interaction between starch particles and water.

The particle size of the sample flours played a role in the wettability of the samples. The tendency of lumping or lump formation increased as the particle size decreased. Brennan et al; (1976) reported that fine particles present large surface area and the mass ratio of small particles causes lumping.

Considering the apparent rate constant and correlation coefficient for the wettability of yam powders high correlation coefficient in all cases show a good fit to first order kinetics for all the samples. (Table 3)

Table 1:- Bulk Density and Wettability of yam flour

Drying Temp (°C)	Sieve Size (nm)	Bulk density (g/cm^3)				Wettability (secs)			
		Blanching time (mins)				Blanching time (mins)			
		0	3	6	9	0	3	6	9
60	425	0.65	0.61	0.62	0.69	42.5	31.5	17.0	15.5
	180	0.63	0.68	0.59	0.65	42.5	33.5	13.5	16.0
	150	0.66	0.69	0.62	0.64	47.0	34.5	16.0	25.5
	75	0.66	0.66	0.62	0.69	78.0	70.0	53.0	50.0
80	425	0.63	0.67	0.63	0.65	40.5	23.0	15.5	11.5
	180	0.63	0.64	0.61	0.67	39.5	25.0	17.5	16 75
	150	0.64	0.64	0.63	0.63	46.0	25.5	23.5	23.0
	75	0.65	0.65	0.59	0.62	64.5	69.0	69.0	67.0
110	425	0.71	0.75	0.74	0.75	36.0	28.3	30.5	24.0
	180	0.72	0.74	0.75	0.75	38.0	31.0	33.0	26.5
	150	0.72	0.73	0.75	0.74	44.5	30.5	32.5	28.5
	75	0.73	0.70	0.73	0.71	45.5	96.0	95.0	68.0

Mean of duplicate determinations:

Table 2: Water Holding Capacity and Dispersibility

Drying Temp (°C)	Sieve Size (nm)	Water holding capacity % Blanching Time (mins)				Dispersibility (%) Blanching Time (mins)			
		0	3	6	9	0	3	6	9
60	425	100	200	200	255	71.1	27.6	6.6	5.8
	180	101	200	200	240	76.7	28.0	20.6	20.0
	150	100	175	200	220	88.7	22.3	26.6	28.3
	75	135	175	200	230	98.6	99.0	99.0	96.6
80	425	150	200	200	200	76.8	12.0	10.2	8.3
	180	180	210	210	195	88.3	18.0	16.0	22.0
	150	180	200	220	195	91.6	12.0	19.0	48.0
	75	140	198	215	196	99.3	98.0	98.3	99.6
110	425	180	170	175	195	84.0	56.0	49.0	27.0
	180	185	180	175	198	94.10	62.0	51.8	36.0
	150	182	182	180	190	95.0	87.5	48.0	41.6
	75	180	180	182	180	99.0	97.5	98.7	95.6

Mean of duplicate determinations.

Table 3: Apparent rate constants and correlation co-efficient for water holding capacity, wettability and dispersibility of yam power

Drying temp °C	Sieve size (nm)	Water Holding Capacity: Rate Constant 10^{-2} x Min^{-1}	Water Holding Capacity: Correlation Coefficient	Wettability: Rate Constant 10^{-2} x Min^{-1}	Wettability: Correlation Coefficient	Dispersibility: Rate Constant 10^{-2} x Min^{-1}	Dispersibility: Correlation Coefficient
60	425	8.90	0.85	-11.0	-0.96	-29.02	-0.96
	180	8.30	0.82	-10.8	-0.95	-14.28	-0.88
	150	7.40	0.81	-.8.4	-0.86	-10.82	-0.66
	75	4.90	0.83	-9.6	-1.00	-0.03	-0.89
80	425	2.50	9.72	-13.58	-0.91	-19.30	-0.96
	180	2.07	0.63	-9.67	-0.95	-14.50	-0.88
	150	2.07	0.70	-8.06	-0.86	-14.50	-0.66
	75	3.5	0.73	-0.60	-1.00	-0.001	-0.89
110	425	0.09	0.64	-3.22	-0.80	-11.98	-0.97
	180	0.04	0.77	-3.45	-0.90	-10.40	-0.99
	150	0.07	0.10	-4.37	-0.83	-9.90	-0.95
	75	0.23	0.77	-5.57	-0.89	-0.23	-0.77

* Rate Constant 2.303 x scope of the log plots.

WATER HOLDING CAPACITY:

The water bound by the different yam flours show that blanching for 3 minutes or more increased the water holding capacity of flours (Table 2). The increase in water holding capacity of the heat processed yam flours could be due to the fact that during blanching, gelatinization of the carbohydrate and swelling of the crude fibre may occur which could lead to increased water absorption. Ayernor (1976) has also observed an increase in water holding capacity and swelling power of yam (***D. rotundata***) with increase in cooking of tissue.

The rate constants for the water holding capacity of yam flours are presenced in Table 3. It is evident that the rate constants for the water holding capacity of yam powders decreased with increase in drying temperature. At the drying temperature of 60, 80 and 110°c, the high correlation coefficients for the different particles of the powder show a good fit to first order kinetic for all the samples.

DISPERSIBILITY

The result of the dispersibility showed that blanching for 3 minutes or more decreased the dispersibility of the flours (Table 2). This observation could be attributed to the crystalization of starch molecules as a result of retrogradation.

The apparent rate constants (Table 3) for the dispersibility of the powders increased with particle size. Almost in all cases, the high correlation coefficient shows a good fit to first order kinetics.

This study indicates that blanching and particle size affected the dispersibility as well as factors such as bulk density, water holding capacity and wettability. The data generated fitted to first order relationship Y = A + BX, where Y = Log outcome of functional tests and X = process variable which indicates reasonable first order relationship with rate constants of potentially predictive nature.

REFERENCES

Armstrong, B. L; Stanley, D. W and Maurice T. J. 1979. Functionality and Protein structure., Ed. Akiva, Pour-EL Acs Symposuim series 92, American Chemical Society, Washington D. C.