Applied Biological Research (2010) 12: 42-49

INFLUENCE OF EMULSIFIER ON THE QUALITY OF VARIOUS EXTRACTION FLOUR PRETZELS

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(Received 4 July, 2010; accepted 11 September, 2010)

ABSTRACT

Studies were carried out to evaluate the effect of extraction rate of flour, viz. 70, 80 and 90%, on proximate composition, rheological and pretzel-making properties. The study revealed that with increase in extraction rate from 70 to 90%, the ash, fat, protein, reducing and total sugar contents showed increase; whileas starch and falling number showed decrease both in flour and pretzels, respectively. Extended extraction rates resulted in coarser flour affecting their rheological properties. Farinogram characteristics like water absorption, dough development time and dough stability increased significantly after 80% extraction rate, while the amylogram characteristics like gelatinization temperature, peak viscosity, peak temperature and viscosity at 95°C decreased with extended extraction rate. Pretzels prepared from different extraction flours exhibited decrease in derived calories and increase of mineral matter with increase in extraction rate. Organoleptically, 70 and 80% extraction pretzels were found best with respect to quality and storage stability. The addition of glycerol momostearate (GMS) at 0.25-0.5% level were suitable for improving texture and storage life of pretzels at 70, 80 and 90% extraction flour pretzels of wheat cv. 'PBW-343' but 70 and 80% gave best results. The 70 and 80% extraction flour pretzels had storage life of 90 days.

Keywords: Acceptability, extraction rate, glycerol momostearate, minerals, pretzels, rheological properties, wheat flour

INTRODUCTION

The yield of flour varies from one quality testing laboratory to another, especially from commercial to laboratory mills. This emphasizes onto the understanding of the influence of extraction rates on flour characteristics. Because of the marked differences in composition between bran and endosperm, and within endosperm itself, the flours which represent varying extraction rates also differ in their composition (Ziegler and Greer, 1971). Kent (1966) reported large variation between the protein content of subaleurone and the inner endosperm in wheat. Further, subaleurone accounted for almost 25% of the total protein of starchy endosperm which was far in excess of its contribution to the weight of endosperm. Ortho and Mander (1975) suggested that in wheat breeding programmes optimum flour yield must be determined to have maximum realization of products from the flour.

Pretzels are very tasty, low calorie nutritious, cooked and baked products made from wheat and are popular snack foods in many developed countries. Hard as well as soft pretzels are made from wheat by manipulation of process operations and by using flour from different varieties (Madonna, 1983). The typical ingredients used in pretzel are flour, water, yeast, malt, shortening, soda and salt. Flour requirements are usually low protein (9.0-9.5%) with high ash content (Matz, 1976; Hoseney, 1986; Groff and Steinbaecker, 1995). The production and consumption of pretzel is increasing at a fast rate because consumers want alternatives to fried snack foods. At present, pretzel production is fully automized in developed countries to meet the rising consumer demands and aspirations, but no such product is available in India. Emulsifiers are used for starch complexing, protein strengthening and aeration of cereal based foods (David, 1981). Sidhu *et al*. (1989) reported increase in the shelf life of chapattis by using surfactants up to 72 hrs. Perusal of literature reveals that only limited studies have been conducted elsewhere in the world and no study seems to be available on pretzel production from Indian wheat. Using the optimized recipe and method (Naik *et al.*, 2007a), the present investigations were carried out on bread wheat variety 'PBW-343' with an objective to evaluate the effect of extraction rate and glycerol momostearate (GMS) on the quality and stability of pretzels.

MATERIALS AND METHODS

Materials

Bread wheat variety 'PBW-343' was obtained from the Department of Plant Breeding, PAU, Ludhiana, India. The wheat was thoroughly cleaned and stored in metallic bins for subsequent use during investigation.

Milling to different extraction rate flours

Cleaned wheat samples (2 kg each) were conditioned at 16% moisture, and rested for 48 hr before milling in Buhler Pneumatic Laboratory Mill (MLU-202, Buhler Brothers, Switzerland) under appropriate conditions of feed rate, roll setting and sifting (Naik *et al.*, 2007b). Base flour of 70% extraction was obtained by mixing break (B_1+B_2+B_3) and reduction (R_1+R_2+R_3) fractions. The 80% extraction rate flour was made by mixing the straight run flour and the flour obtained by recycling shorts through reduction rolls, and the dust obtained from bran by passing it through bran finisher (MLU-302). The 90% extraction rate flour was recovered by combining the straight grade flour with the flour obtained by repeatedly passing shorts and bran through reduction rolls and bran finisher. By these steps, approximately 88-89% extraction flour was obtained. To have 90% extraction, the remaining shorts were ground in a stone grinder, and the flour sifted was mixed with base flour obtained earlier. The flours, recovered from all different steps, were thoroughly mixed to form flours of different extraction rates.

Physicochemical characteristics of flour

Flour samples were analyzed for moisture content, protein, ash, fat, sugars, falling number and pigments using standard AACC procedures (1993). The total starch was determined by the method of Lane and Eynon (1923). Particle size distribution of different samples was estimated by benzene sedimentation method (Simons, 1985).

Rheological studies

Dough characteristics were studied by using a Brabender Faringograph. Farinogram values were derived from a 15 min. mixing curve for 50 g flour (14% moisture content basis) and sufficient distilled water to give a maximum dough consistency centered on 500-BU line according to AACC method (1993). Starch-pasting characteristics were determined by using an Amylograph by taking 70 g flour samples (14% moisture content basis) and 450 ml distilled water. The instrument was set for 1.5°C rise in temperature per min., with an initial adjustment to 30°C.

Optimized recipe for pretzels

For preparation of pretzels, the optimized recipe for pretzels comprized of flour 100 g, water 50 ml, compressed yeast 0.5 g, salt 2 g, ammonium bicarbonate 0.4 g, refined oil 3 ml, and malt extract 2 g.

Surfactants

The commercial food grade glycerol monostearate (GMS), obtained from local market, and added @ 0.25, 0.50 and 0.75% to 70, 80 and 90% extraction flours, respectively, as surfactants.

Malt extract

The malt extract was prepared in the laboratory. Malted barley obtained from the United Breweries, Ludhiana was ground in a hammer mill. The ground material was steeped in water at 40°C for 20 min. at 1:1 ratio (barley: water). It was then heated to a temperature of 65°C with constant stirring for 20 min. This slurry was then filtered through a muslin cloth. After separating the liquid, two more similar extractions were carried out. Then, all the extractions were combined and kept in separating funnels for 6 hr. Sediments were separated and clear supernatant collected was concentrated at a mild heat over a hot plate to about 65°Brix with constant stirring. After cooling, it was kept in the refrigerator for use.

Method of preparation

Ingredients were mixed for 7 min. and dough was extruded through a simple hand operated vermicelli-making machine having a sieve of 4 mm aperture size. Extruded dough threads were manually shaped into oval rings, spread on trays and proved for 10 min. The product was cooked in 1% alkali (NaOH) solution at 81° C for 15 sec., drained and baked at 218° C for 6 min., and then dried at 121° C for 25 min.

Proximate composition of pretzels

Pretzels developed were analyzed for moisture, protein, ash, fat, and sugars by AACC methods (1993), while starch was determined by the method of Lane and Eynon (1923). Calories were calculated by using physiological energy values of foods. The pretzel samples were analyzed for different minerals using the ICP/AAS (inductively coupled plasma atomic absorption spectrophotometer) as prescribed by Lichte *et al.* (1987). The organic matter in the samples was digested by taking 0.5 g of sample and 5 ml of distilled concentrated nitric acid in 100 ml flasks. The samples were kept over-night and next day heated at 120°C using a hot plate till approximately 1 ml was left. Then, 2 ml of hydrogen peroxide was added and heated as before till approximately 1 ml was left. After cooling, 5 ml distilled water was added, and transferred in 10 ml volumetric flasks to make the volume.

Organoleptic evaluation and storage studies

Shelf life studies for pretzels packed in laminated (PE/foil/PE) bags were conducted organoleptically at room temperature (30±2°C), and the products were evaluated for 3 months, drawn at intervals of 15 days. Quality of fresh and stored products was evaluated by a panel of eight semi-trained judges for overall acceptability, on the basis of appearance, texture and flavour (aroma+ taste) using a 9-point hedonic scale (Larmond, 1977).

Statistical analysis

The data obtained was analyzed with the help of statistical software CPCS–1 PAU, Ludhiana, India using completely randomized design. The least significance difference (5% level) between the means was calculated. All the data was ex-pressed at 14% moisture basis, unless otherwise mentioned.

RESULTS AND DISCUSSION

Proximate composition of flour

With the increase in the extraction rate from 70 to 90%, the ash, fat, protein, reducing sugar (% glucose) and total sugar (%glucose) contents increased from 0.58 to 0.89, 0.44 to 0.65, 8.84 to 10.00, and 0.91 to 3.42 and 5.86 to 7.95%, respectively (Table 1). The starch content decreased from 65.59 to 57.11% and falling number value from 382 to 283 sec., respectively. However, the ash, fat and total sugars were found to be similar for 70 and 80% extraction flours; but protein, enzyme activity, reducing sugar and starch were significantly affected by extended extraction rate. No effect was noticed on pigment ß-carotene content with the increase in extraction rate. Decrease in falling number values indicated an increase in α-amylase activity with increase in the extraction rate of flours. Increases in ash, fat, protein and enzyme activity may be attributed to more of aleurone layer and germ entering the flour with high extraction rates. Sankara Rao and Deosthale (1981), Venkateswara Rao *et al.* (1985, 1986), Seung Yong Cho *et al.* (2001) and Vetramani *et al.* (2005) have reported similar effects on proximate composition of flour with extended extraction rates.

Table 1: Effect of extraction rates on the physicochemical characteristics of wheat flour

Parameters	**Extraction rate (%)**			**$CD_{0.05}$**
	70	**80**	**90**	
Ash (%)	0.58	0.62	0.89	0.07
Fat (%)	0.44	0.48	0.65	0.09
Protein (%)	8.84	9.76	10.00	0.18
Reducing sugars (% glucose)	0.91	3.20	3.42	0.91
Non-reducing sugars (% sucrose)	4.70	3.00	4.30	ns
Total sugar (% glucose)	5.86	6.35	7.95	0.49
Total starch (%)	65.59	62.63	57.11	0.24
Pigments (ß carotene, ppm)	4.82	4.82	5.12	ns
Falling number (sec.)	382.00	369.00	283.00	10.00

Particle size distribution of flour

With increase in the extraction rate from 70 to 90%, the particles size range was less than 50 µm and 50-100 µm decreased significantly from 27 to 4% and 33 to 7%, whereas particle sizes more than 100 µm increased from 40 to 89%, respectively (Table 2). Glates and Mar (1983) have reported that increase of coarser particles in the higher extraction rate flours may be due to greater resistance offered by bran during grinding.

Table 2: Effect of extraction rates on particle size distribution of wheat flour

Particle size (µm)	**Extraction rate (%)**		
	70	**80**	**90**
Less than 50	27.00	11.00	4.00
50-100	33.00	29.00	7.00
More than 100	40.00	60.00	89.00

Rheological properties of flour

The farinograph results revealed no difference with respect to water absorption, dough development time and dough stability for 70 and 80% extraction flours, but these parameters showed significant increased in 90% extraction flour from 57 to 60%, 2.00 to 3.50 min. and 2.50 to 3.30 min., respectively, in comparison to 70% extraction flour (Table 3). Ortho and Mander (1975) observed a pronounced decrease in dough strength with increasing extraction rate of flours. They indicated a pronounced decrease in gluten strength with increased extraction rate, despite increased flour protein. These flours produced doughs with gluten network that were more easily disrupted by prolonged mixing, which indicated a change in flour protein quality and, hence, composition. The additional milling required to produce high extraction flours caused increased starch damage by physical abrasion and, consequently, higher water absorption. Qarooni e*t al.* (1994) and Vetramani *et al.* (2005) have also reported an increase in water absorption with increasing extraction rates of wheat flour. The effect of different extraction rates on the pasting properties of flour revealed that gelatinization temperature, peak viscosity, peak viscosity temperature, and viscosity at 95^{o}C decreased with extended extraction rate; however, the values were similar for 80 and 90% extraction flours (Table 3). Peak viscosities of 70, 80 and 90% extraction flours were 862, 830 and 825 BU, and the peak temperatures attained at maximum point of gelatinization 92.5, 87.2 and 86.0^{o}C, viscosities at 95°C 645.0, 520.0 and 495.0 BU, and gelatinization temperatures 62.8, 59.0, and 58.0^{o}C, respectively. The decrease in viscosity was due to increased amylase activity and decreased starch content with increasing extraction rate. Venkateswara Rao *et al.* (1985), Seung Yong Cho *et al.* (2001) and Mousa *et al.* (1979) have found a decrease in peak viscosity with increasing extraction rate of wheat flours.

Table 3: Effect of different extraction rates on rheological properties of flour

Parameters	Extraction rate (%)			$CD_{0.05}$
	70	80	90	
Water absorption (%)	57.0	57.0	60.0	2.35
Arrival time (min.)	1.5	1.5	2.0	ns
Dough development time (min.)	2.0	2.0	3.5	0.95
Dough stability (min.)	2.5	2.5	3.3	0.70
Mixing tolerance index (BU)	90.0	80.0	55.0	ns
Degree of softening (BU)	110.0	130.0	130.0	ns
Gelatinization temperature (^{o}C)	62.8	59.0	58.0	1.80
Peak viscosity (BU)	862.0	830.0	825.0	13.10
Peak temperature (^{o}C)	92.5	87.2	86.0	4.70
Viscosity at 95^{o}C (BU)	645.0	520.0	495.0	49.60

BU = Brabender units

Proximate composition of pretzels

The fat, sugars, protein and calories of pretzels prepared from 70, 80 and 90% extraction flours of wheat variety ‘PBW-343’ increased, while moisture and starch decreased with increase in extraction rate of flour. However, no differences were observed between 80 and 90% extraction pretzels with respect to moisture, protein and reducing sugar contents. The moisture, fat and protein of pretzels prepared from 70, 80 and 90% extraction flours were 8.79, 6.30 and 5.84%; 0.44, 0.48 and 0.65%, and 6.61, 7.19 and 7.35%, respectively, whereas total sugar and starch contents were 9.29, 11.04 and 11.43% and 60.28, 51.20, and 49.64%, respectively (Table 4). The loss of starch content in pretzel production compared to flour may be due to the conversion of starch to sugars on fermentation, cooking and baking resulting in significant gain of total sugars and reducing sugars in pretzels. Besides, increase in total sugars could be due to addition of malt extract in the preparation of pretzels. The energy per 100 g product decreased from 320.2 to 290.42 calories with increase in extraction rate of flour.

Table 4: Effect of different extraction rates on proximate composition of pretzels

Parameters	Extraction rate (%)			$CD_{0.05}$
	70	80	90	
Moisture (%)	8.79	6.30	5.84	1.03
Ash (%)	3.26	3.28	3.32	ns
Fat (%)	1.72	1.78	1.86	0.05
Protein (%)	6.61	7.19	7.35	0.54
Reducing sugars (% glucose)	5.16	6.70	6.77	0.82
Non reducing sugars (% sucrose)	3.85	4.13	4.43	0.23
Total sugars (% glucose)	9.29	11.04	11.43	0.24
Starch (%)	60.28	51.20	49.64	0.13
Calories 100 g^{-1}	320.20	293.74	290.42	0.29

Mineral composition of pretzels

The effect of extraction rate on mineral composition of pretzels revealed that sodium, calcium, copper, potassium, magnesium, manganese, phosphorus and sulphur for 70, 80 and 90% extraction flour pretzels increased, while iron and zinc decreased with increasing extraction rates (Table 5). Pretzels from 70, 80 and 90% extraction flours had 845.36, 903.45 and 950.62 mg total minerals 100 g^{-1} product. The increase in mineral content of pretzels with extended extraction rate might be due to increased proportion of outer branny layers in the flour. Sodium content was higher in the product, as cooking was done in alkali solution. Pedersen and Eggum (1983) observed an increase in proximate composition, mineral composition and amino acid composition of hard winter wheat, when extraction rate increased from 66 to 100%.

Table 5: Effect of different extraction rates on mineral composition of pretzels

Minerals (mg 100 g^{-1})	Extraction rate (%)			$CD_{0.05}$
	70	80	90	
Sodium	554.60	593.05	556.70	0.60
Calcium	18.95	20.98	19.24	0.16
Copper	0.38	0.40	0.60	0.005
Iron	5.61	4.74	4.11	0.005
Potassium	76.57	87.67	129.62	0.16
Magnesium	17.48	23.13	32.40	0.14
Manganese	0.46	0.51	0.92	0.003
Phosphorus	103.34	109.92	145.82	0.20
Sulphur	49.88	53.24	54.80	0.26
Zinc	18.09	9.80	6.41	0.13
Total minerals	845.36	903.45	950.62	-

Organoleptic evaluation of pretzels

The mean acceptability scores were higher than control (7.9 out of 9.0) in 70 and 80% extraction flour pretzels. The pretzels of 70 and 80% extraction flour, packed in laminated bags, had statistically similar but highest mean acceptability score of 8.0 and 7.6 out of 9.0 than that of 5.4 in 90% extraction flour pretzels. The overall acceptability scores are based on average score of appearance, flavour and texture. Incorporation of GMS, irrespective of levels and extraction rate, exhibited improvement in storage stability. The GMS levels of 0.25-0.50%, irrespective of extraction rate, were superior in formulation. The highest acceptability score of 8.8 out of 9.0 were recorded in fresh pretzels from 70 and 80% extraction flour pretzels; whereas 90% extraction pretzels had lowest score of 6.9. The 70 and 80% extraction flour pretzels with 0.25-0.50% GMS recorded acceptability for 90 days of storage though slight decrease in sores was observed. The 90% extraction flour pretzels recorded significantly lower acceptability scores after 30 days of storage as there was drastic decrease in the score values. Except extraction rate x GMS, all other interactions were found significant.

Table 6: Effect of GMS on the quality and stability of different extraction flour pretzels

Extraction rate (%)	% GMS	Storage days							Mean
		0	15	30	45	60	75	90	
	0.00	7.9	7.9	7.6	7.6	7.6	7.5	7.2	7.6
	0.25	8.8	8.8	8.8	8.7	8.8	8.6	8.5	8.7
70	0.50	8.8	8.7	8.8	8.6	8.6	8.5	8.5	8.6
	0.75	7.3	7.3	7.2	7.1	6.9	6.8	6.3	7.0
	Mean	8.2	8.2	8.1	8.0	8.0	7.9	7.6	8.0
	0.00	7.9	7.7	7.7	7.6	7.5	7.6	7.4	7.6
	0.25	8.8	8.7	8.7	8.8	8.6	8.7	8.3	8.7
80	0.50	8.8	8.6	8.6	8.0	7.8	7.6	6.0	7.9
	0.75	6.9	6.8	6.3	6.3	6.1	5.9	5.9	6.3
	Mean	8.1	8.0	7.8	7.7	7.5	7.5	6.9	7.6
	0.00	7.0	6.8	6.8	6.7	6.5	5.5	5.0	5.2
	0.25	6.9	6.8	6.8	6.0	5.3	5.2	5.0	6.0
90	0.50	6.7	6.4	6.4	6.0	5.0	5.0	5.0	5.8
	0.75	6.1	6.0	5.2	5.1	4.2	3.0	2.8	4.6
	Mean	6.7	6.5	6.3	6.0	5.3	4.7	4.5	5.4
	Overall mear	7.7	7.6	7.4	7.2	6.9	6.7	6.3	

$CD_{0.05}$ Extraction Rate (E) = 0.14, Storage (S) = 0.21, GMS = 0.16;
E × S = 0.37, E × GMS = ns, S × GMS = 0.43, E × S × GMS = 0.74

Each value is a mean of 8 replicates

Lower mean scores at 0.75% level of GMS resulted due to development of after taste of surfactant in fresh as well as stored pretzels. The 90% extraction flour pretzels recorded lowest mean acceptability scores at all levels of GMS concentration but was having poorest acceptability score of 4.6, irrespective of GMS concentration. The results, thus, indicated that 70 and 80% extraction pretzels with 0.25-0.50% GMS exhibited best quality and storage stability. The poor acceptability scores of 90% extraction flour pretzels might be due to higher amount of branny layers and fat content, making the product more fragile, rancid during storage and of reduced appearance. Sidhu *et al.* (1989) reported 0.5% GMS addition to flour for Chapati making best with respect to quality and shelf life. David (1981) reported that normal-use levels of surfactants were 0.25-0.5% of flour weight. He described starch complexing, protein strengthening and aeration the primary functions of emulsifiers and reported texture improvement in cookies. Birnbaum (1979) reported considerable improvement in quality and shelf life of snack foods by using surfactants. He stated that crackers prepared by monoglyceride surfactants had a smoother surface and a desirable shortness and were less hygroscopic than crackers without the monoglyceride.

Conclusions: The variations in extraction rates resulted in significant differences of physicochemical, rheological and pretzel-making characteristics of wheat flour. Therefore, when comparing the quality testing results, the effect of extraction rates must be considered. Flours of 70 and 80% extraction rates and use of GMS level at 0.25-0.50% were particularly suitable with respect to pretzel production, quality and storage stability and pretzels packed in aluminium-based laminate had storage life of 90 days at room temperature.

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