Influence of defatted soy flour addition on the quality and stability of pretzel type product

Haroon Rashid Naik · K. S. Sekhon

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Abstract Effect of soya flour addition to 70% extraction bread wheat flour (PBW-343) at (0, 5, 10, 20 & 30%) was investigated for physico-chemical, dough handling and pretzel making properties. Results revealed that with increasing DSF addition, farinogram characteristics; water absorption, arrival time, dough development time and dough stability increased while mixing tolerance index and degree of softening decreased. Amylogram characteristics gelatinization temperature, peak viscosity, peak temperature and viscosity at 95 °C decreased with extended rate of DSF addition. Pretzels developed with different levels of DSF addition observed decrease in moisture, fat, non reducing sugars and starch where as ash, protein, reducing and total sugars increased compared to control. Calories calculated from proximate composition showed lower values than control due to high protein and low fat soy flour addition. Minerals increased significantly with increased levels of defatted soy flour addition. Organoleptic evaluation revealed that 5% level of soy flour blended pretzels were found best with respect to texture, colour and flavor on the basis of mean acceptability scores. Pretzels recorded shelf life of 90 days in laminated pouches irrespective of the level of DSF addition.

Keywords Wheat flour · Defatted soy flour (DSF) · Rheological properties · Pretzels · Minerals and acceptability

Introduction

Soybeans have a great potential as human food because of their high level of good quality protein, unique functional and nutritional properties. One of the most promising uses of soybeans is the fortification of cereal based products particularly baked goods because the profile of amino acids in soybeans is complementary to that in most cereals (Klein et al. 1995). Soybeans supply all nine essential amino acids and have cholesterol reducing and anti carcinogenic properties (Riaz 1999). However one of the continuing impediments to acceptance of soy foods is their “beany taste” due to lipoxygenase catalyzed oxidation of soy bean oil to volatile compounds such as, hexanal (Rackis et al. 1979 and Wilson 1999). These compounds are partially removed from soy flour by hexane defatting and any beany flavour if left is marked by the ingredients used for product preparation.

Pretzels are a 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 manipulating process operations and by using flour from different varieties (Madonna 1983). 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; Hosene 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 automated in the developed countries to meet the rising consumer demands and aspirations but no

H. R. Naik (✉)
Division of Post Harvest Technology,
Sher-e-Kashmir university of Agricultural Sciences
and Technology of Kashmir,
Shalimar Campus,
Srinagar, Jammu & Kashmir 191121, India
e-mail: haroonnaik@gmail.com

K. S. Sekhon
Department of Food Science and Engineering,
Punjab Agricultural University Ludhiana,
Punjab 141004, India

such product is available in India. Perusal of literature shows only limited studies elsewhere and no study seems to be available in pretzel production from Indian wheats. Using the optimized recipe and method developed for production of pretzels, investigations were conducted on bread wheat variety PBW-343 “to work out optimum level of soy flour addition for pretzel production and to study its effect on the quality and stability of pretzels”.

Materials and methods

Test materials used

Bread wheat variety (‘PBW-343’) was obtained from Department of Plant Breeding, Punjab Agricultural University, Ludhiana, India. Wheat was thoroughly cleaned and stored in metallic bins for subsequent use in the investigation.

Milling of wheat

Test samples (2 Kg) were conditioned at 16% moisture and rested for 48 h before milling in the Buhler Pneumatic Laboratory Mill (MLU-202) under appropriate conditions of feed rate, roll settings and siftings. Base flours of 70% extraction was obtained by mixing break (B1+B2+B3) and reduction (R1+R2+R3) fractions. The flour was stored in air tight (Pet) Jars for use in the analysis.

Soy flour addition

Control flour of 70% extraction rate of wheat variety PBW-343 was supplemented with defatted soybean flour at 5, 10, 20 and 30% levels.

Physico-chemical characteristics of flour

Wheat flour and defatted soy flour samples were analyzed for moisture content, protein, ash, fat, sugars, falling number and pigments using standard AACC procedures AACC (2000) while starch was determined by the method of Lane and Eynon (1923).

Rheological studies

Dough characteristics of wheat flour supplemented with defatted Soy flour (DSF) were studied by using Brabender Faringograph and Amylograph. Farinogram values were derived from a 15 min mixing curve for 50 g flour (14% moisture content basis) and sufficient distill water to give a maximum dough consistency centered on the 500-BU line according to AACC method (2000). Amylogram values were derived from 70 g flour (14% moisture content basis)

and 450 mL of distilled water. The instrument was set for 1.5 °C rise in temperature per minute with an initial adjustment of temperature to 30 °C.

Pretzel ingredients

Fresh compressed yeast (*Saccharomyces cerevisiae*), shortening (refined cotton seed oil), and sodium chloride of high purity (E. Merck India Ltd, Bombay), ammonium bicarbonate (BDH) and malt extract prepared in the laboratory was used in pretzel production. Defatted soy flour procured from local market was used for protein fortification of the pretzels.

Malt extract

Malt extract was prepared in the laboratory of Department of Food Science and Technology Punjab Agriculture University Ludhiana, India. Malted barley obtained from the United Breweries, Ludhiana India was ground in the 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 about 65 °C with constant stirring for 20 min. This slurry was then filtered through a muslin cloth. After separating the liquid, 2 more similar extractions were carried out. Then, all the extractions were combined and kept in separating funnels for 6 h. 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.

Optimized recipe for pretzels

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 were used in the preparation of pretzels.

Method of preparation

Ingredients were mixed for 7 min and the 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 proofed for 10 min. The product was cooked in 1% alkali (NaOH) solution at 81 °C for 15 s, 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 AACC (2000) while starch was determined by the method of Lane and Eynon

(1923). Calories were calculated by using physiological energy values of foods.

Minerals

The pretzel samples were analyzed for different minerals using the ICAP (Inductively coupled Atomic Absorption Spectrophotometer) as per the method standardized by Department of Soils, Punjab Agricultural University Ludhiana, India. 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 flask. Kept overnight and next day heated samples at 120 °C using hot plate till approximately 1 mL was left. 2 mL of hydrogen peroxide was added and heated as before till approximately 1 mL was left. Cooled and added 5 mL distilled water and transferred in 10 mL volumetric flask to make the volume. The samples were then subjected to analysis using the ICAP (Inductively coupled Atomic Absorption Spectrophotometer).

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 an interval of 15 days. Quality of fresh and stored products were evaluated by a panel of ten semi trained judges for overall acceptability on the basis of appearance, texture and flavor using 9 point Hedonic scale (Larmond 1977).

Statistical analysis of data

The data collected on different characteristics were analyzed with the help of a statistical software CPCS – 1 P. A. U. Ludhiana, India using CRD (completely randomized design) and least significance difference ($P \leq 0.05$) between the means

was calculated using three replications. All the data was expressed at 14% moisture basis unless otherwise mentioned.

Results and discussion

Proximate composition of soybean and wheat flour

Defatted soybean flour used for protein enrichment of pretzels had 7.75, 6.16, 0.25, and 38.1% moisture, ash, fat and proteins where as the control flour had 15.50, 0.58, 0.44 and 8.84% moisture, ash, fat and proteins respectively (Table 1). Besides control flour recorded 0.91, 4.70, 5.86, 65.59, 4.82 and 382.00 of reducing sugars (%), non-reducing sugars (%), total sugars (%), starch (%), pigments (ppm) and falling number (sec) respectively. Riaz 1999 reported defatted soybean flour as more concentrated source of protein than full fat soy flour having protein content up to 50% than that of full fat flour.

Rheological properties of defatted soy flour (DSF) supplemented wheat flour

Farinographic studies revealed (Table 2) that the water absorption capacity, arrival time, dough development time and dough stability increased from 54.30 to 68.20%, 1.50 to 2.00 min, 1.90 to 2.70 min and 1.70 to 4.00 min respectively, where as mixing tolerance and degree of softening decreased from 90 BU to 55 BU and 115 BU to 80 BU respectively with extended DSF addition. Decrease in mixing tolerance indicated strengthening of flour with DSF addition. Amarjeet et al. (1995) and Riaz 1999 have reported increase in dough water absorption by soy flour addition because of higher protein content. Serna-Saldivar et al. (1988), Ribotta et al. (2005), Sudha et al. (2011) and Ammar et al. (2011) also reported increase in water absorption, dough development time, dough stability and decrease in mixing tolerance index and degree of softening

Table 1 Physico- Chemical composition of wheat and defatted soybean flour

Parameters	Wheat flour	Defatted soybean flour
Moisture (%)	15.50	7.75
Ash (%)	0.58	6.61
Fat (%)	0.44	0.25
Protein (%)	8.84	38.10
Reducing sugars (%glucose)	0.91	–
Non-reducing sugars (% sucrose)	4.70	–
Total sugar (%glucose)	5.86	–
Starch (%)	65.59	–
Pigments (ppm)	4.82	–
Falling number (Sec)	382.0	–

Table 2 Effect of defatted soy flour addition on rheological properties of flour

Parameters	Levels of defatted soy flour (DSF) addition (%)					
	0	5	10	20	30	C.D ($P \leq 0.05$)
Farinographic properties						
Water absorption (%)	54.30	55.30	56.70	62.50	68.20	2.9
Arrival time (min)	1.50	1.50	1.60	1.70	2.00	NS
Dough development time (min)	1.90	2.00	2.20	2.40	2.70	0.3
Dough stability (min)	1.70	2.50	2.50	3.50	4.00	0.86
Mixing tolerance index (BU)	90.00	90.00	70.00	60.00	55.00	14.0
Degree of softening (BU)	115.00	110.00	105.00	95.00	80.00	21.0
Amylographic properties						
Gelatinization temperature (°C)	62.8	60.2	59.8	58.3	57.8	2.1
Peak viscosity (BU)	738.0	730.0	590.0	445.0	280.0	21.3
Peak viscosity temperature (°C)	92.5	87.5	87.2	86.0	86.0	1.4
Viscosity at 95 °C (BU)	645.0	480.0	360.0	330.0	250.0	42.4

Expressed at 14% moisture basis
Values are mean of 3 replications

time with the incorporation of different types of soy flour in their studies.

Pasting properties of 70% extraction flour of PBW-343 (Table 2) revealed significant decrease in gelatinisation temperature, peak viscosity, peak viscosity temperature and viscosity at 95 °C at all levels of soyflour addition compared to control. The mean values of gelatinization temperature were statistically similar at different levels of soyflour addition. Temperature of gelatinization decreased from 60.2 °C to 62.8 °C, peak viscosity 738 BU to 280 BU, temperature at peak viscosity 92.5 °C to 86.0 °C and viscosity at 95 °C 645 BU to 250 BU with extended level of DSF fortification.

Effect of defatted soybean flour addition on proximate composition of pretzels

Effect of defatted soybean flour addition on proximate composition of pretzels is represented in Table 3. Moisture content did not follow any regular trend with the addition of

defatted soyabean flour. Decreasing trend was observed incase of starch(%), Non-reducing Sugars (%) and fat(%) with addition of increasing levels of DSF. However, Ash (%), Protein(%), Reducing Sugars(%) and Total Sugars(%) showed increasing trend with the addition of DSF. Maximum Ash (3.37%), Protein (15.28%), Reducing Sugars (9.26%) and Total Sugars (11.05%) were found at 30% level of addition. Similar trend was in proximate composition was observed by Adekun et al. (2005) while working on effect of soybean substitution on some physical compositional and sensory properties of kokoro (a local maize snack).

Effect of defatted soybean flour addition on mineral composition of pretzels

Table 4 depicts the effect of defatted soybean flour addition on mineral composition of pretzels, a significant increase in total minerals of pretzels with increasing level of soy fortification compared to control was observed. An increase

Table 3 Effect of defatted soybean flour addition on proximate composition of pretzels

Parameters	Levels of Defatted soy flour (DSF) addition (%)					
	0	5	10	20	30	C.D ($P \leq 0.05$)
Moisture (%)	8.79	5.88	6.96	5.07	8.55	0.98
Ash (%)	2.92	3.02	3.25	3.32	3.37	0.19
Fat (%)	1.72	1.44	1.43	0.86	0.54	0.07
Protein (%)	6.61	8.66	9.92	12.72	15.28	0.35
Reducing sugar (% glucose)	5.16	6.07	6.10	6.52	9.26	0.004
Non reducing sugar (%sucrose)	3.85	3.59	3.52	3.12	1.70	0.92
Total sugar (%glucose)	9.29	9.38	9.77	10.30	11.05	0.67
Starch (%)	60.28	49.17	48.26	46.56	37.56	0.78
Calories per 100 g	320.2	286.1	284.7	281.8	260.4	1.33

Expressed at 14% moisture basis
Values are mean of 3 replications

Table 4 Effect of defatted soybean flour addition on mineral composition of pretzels

Mineral (mg/100 g)	Levels of Defatted soy flour (DSF) addition (%)					C.D ($P \leq 0.05$)
	0	5	10	20	30	
Sodium	593.05	602.04	602.32	552.71	592.47	0.58
Calcium	18.95	30.48	37.49	50.80	68.43	0.67
Copper	0.38	0.33	0.33	0.81	0.62	0.005
Iron	5.61	10.04	5.70	5.85	5.86	0.54
Potassium	76.57	131.05	169.06	243.82	315.35	0.64
Magnesium	17.48	27.34	33.21	47.55	60.09	0.10
Manganese	0.46	0.62	0.62	0.78	0.89	0.004
Phosphorus	103.35	118.01	125.71	149.01	169.87	0.30
Sulphur	49.88	61.60	62.08	78.09	91.37	0.19
Zinc	18.09	6.42	4.65	6.66	6.80	0.17
Total minerals	883.83	987.93	1041.17	1136.08	1315.75	0.81

Expressed at 14% moisture basis

Values are mean of 3 replications

of 11.8, 17.8, 28.5 and 48.9% of total minerals was observed at 5, 10, 20 and 30% levels of soy fortification. Total minerals increased from 883.83 mg/100 g in control to 1315.75 mg/100 g at 30% level of DSF fortification. Calcium, potassium, magnesium, Phosphorus and sulphur significantly increased in pretzels with increasing level of defatted soy flour addition. Zinc is the only micronutrient which decreased significantly from control up to 20% level of soy addition. Sodium content had the highest amount out of the 10 minerals because cooking was done in alkali solution. Range of sodium content at 552.71–602.04 mg/100 g was observed at different levels of fortification compared to 593.05 mg/100 g of control. Fellers et al. (1976) reported increase of Ca, P, K, Mg, Na and Fe with increasing levels of

defatted soy fortification flour in bread. Khan et al. (2005) have reported increase in micronutrients by incorporation of soy hulls in wheat flour.

Effect of defatted soybean flour on the acceptability and Storability of pretzels

The data in Table 5 depicted that 5% level of defatted soy flour added fresh pretzels packed in Aluminium based laminated bags recorded highest acceptability mean score 7.0 followed by 6.13 at 10% level of DSF of addition, but the values were lower than control (8.0). Color of the product was badly affected with increasing levels of soy flour addition in the pretzels. Pretzels prepared from wheat

Table 5 Effect of defatted soybean flour addition on the acceptability of pretzels

Storage days	Percent soy flour addition					Factor means
	0	5	10	20	30	
Fresh	8.00	7.00	6.13	4.63	3.00	5.75
15	8.00	6.90	6.00	4.63	2.75	5.75
30	8.00	6.88	5.88	4.63	2.63	5.65
45	8.00	6.88	6.00	4.63	2.88	5.65
60	8.00	6.88	5.88	4.50	2.75	5.65
75	8.00	6.88	5.75	4.50	2.63	5.60
90	7.75	6.63	5.75	4.50	2.63	5.50
Factor Means	8.00	6.90	5.9	4.6	2.80	

Mean of 10 judges: 9 point hedonic scale

C.D ($P \leq 0.05$)

Soybean flour 0.19

Storage NS

Soybean flour x storage NS

Expressed at 14% moisture basis

Values are mean of 3 replications

flour having 20 and 30% level of DSF were totally unacceptable as they had dark color and burnt taste. Color was affected due to higher amount of non enzymatic browning with protein enrichment. Factor means with respect to levels too reported 5% level to be most acceptable up to 90 days storage. The mean scores of acceptability of pretzels at fresh and after 90 days storage varied significantly at different levels of soy fortification. Serna-Saldivar et al. (1988) reported better colour scores of bread at 8% level of defatted soybean meal compared to 12% level of addition but lower texture and flavour scores than the control bread. Naik et al. (2007) have reported maximum shelf life of 90 days in pretzels prepared from “PBW-343”.

Conclusion

Based on rheological and organoleptic studies, defatted soy flour addition up to 10% level is suitable for pretzel production however to have better storage stability, 5% level of addition is the best.

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