 Copyright © 2011 NLSS, Vol. 2(1), Jan 2012, pp. 107-115

Development of Vitamin and Dietary Fibre Enriched Carrot Pomace and Wheat Flour based Buns

Kshitij Kumar[1,*] and Navneet Kumar[2]
[1,*]Agricultural Engineering Department, Sir Chhotu Ram Institute of Engineering and Technology, CCSU, Meerut
[2]Agricultural Engineering Department, Rastriya Kisan (P G) College, Shamli, Muzaffarnagar

Buns are basically small sized wheat based bread, which are very popular due to its small shape and complete consumption at one time. The buns are generally used as burgers and other fast food items. The buns do not possess a good quantity of vitamins and dietary fiber. Hence, studies were conducted to develop carrot pomace and fine wheat flour based buns. Product development was done by conventional method utilizing carrot pomace in the different proportions of (0, 2.5, 5, 7.5 and 10%). All the ingredients were mixed to obtain good consistency dough, later on these were baked in hot air-oven at 177±2^{0}C for up to 40 minutes to a golden brown Colour. It was observed that the expansion, water solubility and absorption index decreased with the increase in pomace proportion, whereas bulk density and moisture content increased with the increase in pomace proportion. It was further noted that the expansion, water solubility and absorption index and bulk density were having significant correlation to the pomace proportion ($p<0.05$). The buns prepared with carrot pomace at 2.5% levels, showed a very good result in sensory evaluation. The product was recommended for production of carrot buns.

Keywords: Carrot Pomace Powder, Bakery Buns, Water Solubility Index, Water Absorption Index.

1. INTRODUCTION

The present mode of utilization of carrot is, either in the form of raw, cooked vegetable, sweet meats or as juice and beverages. It is widely used as a salad, pickles, and used for mixed juices, jam, jelly, soups etc. The carrot juice is used in fabricated baby foods, which are most popular throughout the world. Efforts have also being made to extend the shelf life of carrot by drying, canning, and freezing, fermenting, pickling, dehydrating and manufacturing many products such as murabba, soup, fabricated baby food and juice.

Fruit and vegetable juices have become important in recent years due to overall increase in natural juice consumption as an alternative to the traditional caffeine containing beverages such as coffee, tea, or carbonated soft drinks[1]. Carrot juice has particularly high content of pro-vitamin A (beta carotene) and is also high in B complex vitamins and many minerals including calcium, copper, magnesium, potassium, phosphorus, iron and folic acid. Juice is also good option for its availability throughout the year. Heavy losses have been reported due to improper handling, transport, storage conditions, marketing and processing techniques in spite of nutritional and therapeutic value. Carrot pomace is the byproduct of carrot juice extraction unit. The juice yield in carrots is only 60-70%, and even up to 80% of carotene may be lost with left over carrot pomace[2,3]. It also has good

ISSN : 2249-9970 (Online), 2231-4202 (Print) Recived: 23.11.11, Accepted: 31.12.11

residual amount of all the vitamins, minerals and dietary fibre. It contains valuable compounds, such as vitamins and dietary fiber. The juice cannot be stored for longer period, whereas carrot pomace can be stored even at room temperature for longer periods after dehydration the pomace.

Carrot pomace is a rich source of antioxidants, natural source of alpha and beta carotene, which have been shown to exhibit health-promoting effect. Kumar *et al*[4,5,6] reported the incorporation of carrot pomace in extrudates and cookies. Only few other unpublished reports are available on the utilization of carrot pomace in the preparation of bread, cake, dressings and pickles, and for the production of functional drinks. The food processing industry produces large quantities of waste co-products. Therefore, a study was planned to develop the carrot pomace based buns. The physical properties of buns were studied along with sensory characteristics.

2. MATERIAL AND METHODS

2.1. Preparation of Carrot Pomace Powder

Commercial variety (Pusa Kesar) was procured from local market, Meerut, Uttar Pradesh, India. These were washed in running tap water number of times to remove extraneous material. Trashes were removed with a plane stainless steel knife and trimming was also done. A juice mixer grinder cum food processor (Make: Supremo DLX, Maharaja Appliance limited, New Delhi, India) was used to extract carrot juice using the method reported by Kumar *et al*[4,5,6]**.** The pomace was collected for further studies.

A hot air oven (Make: Osaw Industrial Products Pvt. Ltd., Haryana, India) was used for drying carrot pomace, which could regulate drying air temperature upto 250°C with ±2°C accuracy. The dryer consisted of a preheating and heating chamber with thermostat based control unit, an electrical fan, and measurement sensors. The samples were spread over the trays and the temperature of the dryer was set to 60°C. The drying procedure continued till the moisture content of the sample was reduced to about 5 ±1% (wet basis). The grinding was performed using the same food processor with grinder attachment. The material was ground to pass through the sieve of 2 mm size. The pomace was stored in sealed polythene bag for further use.

2.2. Buns Preparation

Fine wheat flour was replaced partially with carrot pomace at levels of 0, 2.5, 5.0, 7.5 and 10.0%. All Ingredients for bun preparation (carrot pomace, fine wheat flour, salt, sugar, yeast) were mixed using the same food processor with mixer attachment and water was further added to make proper dough. The ingredients were kneaded with hands till good consistency dough was prepared. The yeast suspension was prepared by adding distilled water from dry yeast. The dough was kept on a hot place after being covered with a muslin cloth as these were raised properly. These were punched to remove the excess gasses. These were cut in to suitable sized and prepared the pallets by hand. These are baked at

177± 2^0C up to 40 minutes up to a golden colour is seen.

2.3. Determination of Responses

2.3.1. Moisture Content

The moisture content of all the extrudates will be measured by using a hot air oven method. The mass of the empty moisture box was noted in the starting. The wet sample were filled in the boxes, weighed and kept in hot air oven at 100°C for 24 hours. The samples were taken out and gain weighed after cooling in desiccators[7].

2.3.1. Expansion

The ratio of diameter of buns to the diameter of pallets was used to express the expansion of buns. The diameter of the buns was measured, at 10 different positions along the sides of each, using a vernier caliper. The surface expansion was estimated by the expansion in area with the original pallet. The volumetric expansion was estimated by the volumetric displacement method. Lateral expansion (LE, %) and Surface Expansion (SE, %) was then calculated using the mean of the measured diameters:

2.3.3. Bulk Density

Bulk density is defined as the mass of solid particles of the material divided by the total volume they occupy. The total volume includes particle volume, inter-particle void volume and internal pore volume. Bulk density is not an intrinsic property of a material; it can change depending on how the material is handled. Bulk density **(**BD**,** g/cm^3) was calculated according to the following expression.

2.3.4. Water Absorption Index (WAI) and Water Solubility Index (WSI) of Extrudates

WAI and WSI were determined according to the method developed for cereals[8,9,10]. The ground extrudates were suspended in water at room temperature for 30 min, gently stirred during this period, and then centrifuged at 3000g for 15 min. The supernatants were decanted into an evaporating dish of known weight. The WAI was the weight of gel obtained after removal of the supernatant per unit weight of original dry solids. The WSI was the weight of dry solids in the supernatant expressed as a percentage of the original weight of sample.

3. RESULT AND DISCUSSIONS

3.1. Expansion

It was observed from Table 1 and Fig. 1 that the lateral expansion decreased with the increase in pomace proportion. The lateral expansion decreased from 147.65% to 115.93%, whereas surface expansion reduced from 513.33% to 366.25%. The *F* values for lateral and surface expansion were 57.75% and 59.79% against *F* critical value of 3.47 (Table 2), indicates the variation in lateral and surface expansion was significant (p<0.05). The expansion of bun takes place due to gelatinization of starch at higher temperatures, whereas the increase in pomace proportion signifies the reduction in availability of starch for gelatinization due to decrease in wheat flour proportion. Therefore, the expansion of bun reduced with the increase in carrot pomace, Similar finding have been reported by Kumar *et al*[2,3].

Table 1: Variation of Responses in Bun Attributes due to increase in Pomace Proportion

Sample	Pomace Propor. (%)	Linear Expan. (%)	Surface Expan. (%)	Bulk Density (g/cm3))	Water Solu. Index (%)	Water Absorp. Index (g/g)	Moisture Content (%)	Overall Accept.
S_0	0.0	147.65	513.33	0.18	3.62	4.07	24.68	7.00
$S_{2.5}$	2.5	134.84	451.58	0.21	3.47	3.44	24.70	7.50
S_5	5.0	127.79	418.90	0.25	3.33	2.40	24.86	6.67
$S_{7.5}$	7.5	123.87	401.32	0.26	2.41	2.06	25.90	5.67
S_{10}	10.0	115.93	366.25	0.30	2.19	1.67	26.89	5.00

3.2. Bulk density

It can be noted from Table 1 and Fig. 1 that the bulk density increased with the increase in pomace proportion. The bulk density increased from 0.18 to 0.33 g/cm³. The *F* values for bulk density was 203.7 against F critical value of 3.47 (Table 2), indicates the variation in density was significant (p<0.05). The reduction in density of buns is attributed to the increase in carrot pomace and decrease in starch proportion, which is mainly responsible for expansion. The reduction in expansion resulted in increase in bulk density.

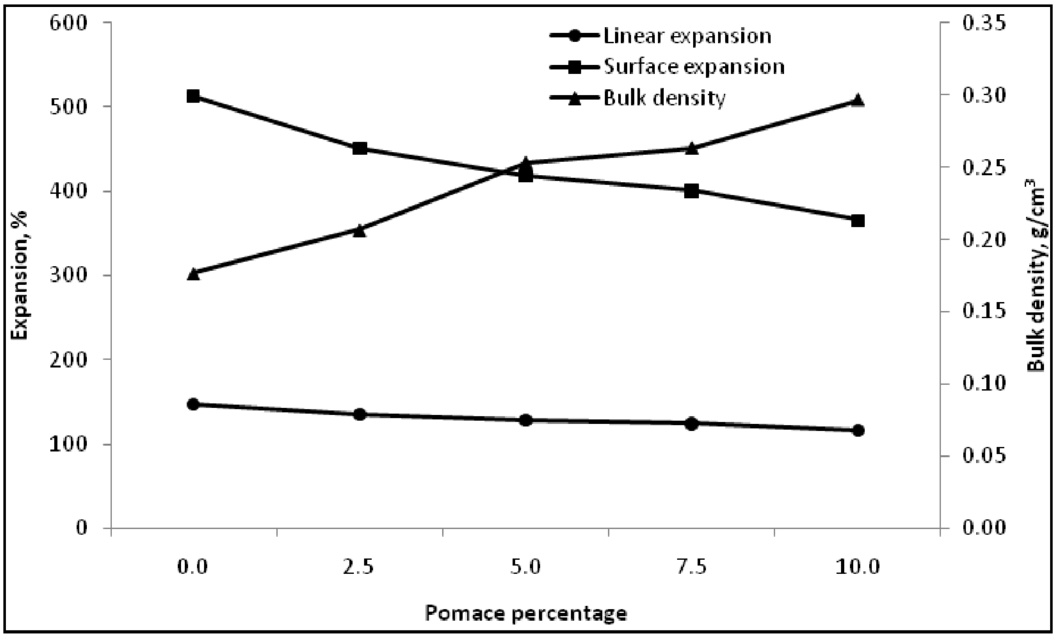

Fig. 1: Variation in Expansion and Bulk Density due to increase in Pomace Proportion in fine Wheat Flour based Buns

Table 2: ANOVA for Variation in Bun Attributes due to increase in Pomace Proportion

Source of Variation	*SS*	*df*	*MS*	*F*	*p-value*	*F crit*
Lateral expansion (%)						
Between Groups	1726.629	4	431.6572	57.75708	7.12E-07	3.47805
Within Groups	74.73668	10	7.473668			
Total	1801.365	14				
Surface Expansion (%)						
Between Groups	37256.15	4	9314.039	59.78988	6.04E-07	3.47805
Within Groups	1557.795	10	155.7795			
Total	38813.95	14				
Bulk density (g/cm^3)						
Between Groups	0.02716	4	0.00679	203.7	1.56E-09	3.47805
Within Groups	0.000333	10	3.33E-05			
Total	0.027493	14				

Source of Variation	*SS*	*df*	*MS*	*F*	*p-value*	*F crit*
Water Solubility Index (%)						
Between Groups	5.168985	4	1.292246	38.70145	4.69E-06	3.47805
Within Groups	0.333901	10	0.03339			
Total	5.502887	14				
Water Absorption Index(g/g)						
Between Groups	11.92129	4	2.980323	26.46824	2.67E-05	3.47805
Within Groups	1.126	10	0.1126			
Total	13.04729	14				
Moisture Content (%)						
Between Groups	11.29071	4	2.822677	0.570975	0.689911	3.47805
Within Groups	49.43607	10	4.943607			
Total	60.72677	14				
Overall Acceptability						
Between Groups	12.4	4	3.1	16.90909	0.00019	3.47805
Within Groups	1.833333	10	0.183333			
Total	14.23333	14				

3.3. Water Solubility Index and Absorption Index

Water solubility index is generally used as an indicator of degradation of molecular components. It measures the degree of starch conversion during baking which is the amount of soluble polysaccharide released from the starch component after processing[9]. The WAI measures the volume occupied by the starch after swelling in excess water, which maintains the integrity of starch in aqueous dispersion[11]. Gelatinization, the conversion of raw starch to a cooked and digestible material by the application of water and heat, is one of the important effects that baking has on the starch component of foods. Water is absorbed and bound to the starch molecule with a resulting change in the starch granule structure. It was observed from Table 1 and Fig. 2 that the water solubility and absorption index decreased with the increase in pomace proportion. Water solubility index decreased from 3.62 to 2.19%, whereas water absorption index reduced from 4.07 to 1.67 g/g of gel produced. The F values for WSI and WAI were 38.70 and 26.46 against F critical value of 3.47 (Table 2), indicates the variation in WAI and WAI was significant ($p<0.05$). The decrease in WSI may be attributed to the reduction in the amount of the starch available for gelatinization for degradation and similar effect on WAI was also observed due to increase in pomace proportion. Decrease in water absorption index due to increase in pomace proportion have also been reported by Tangirala *et al*[12].

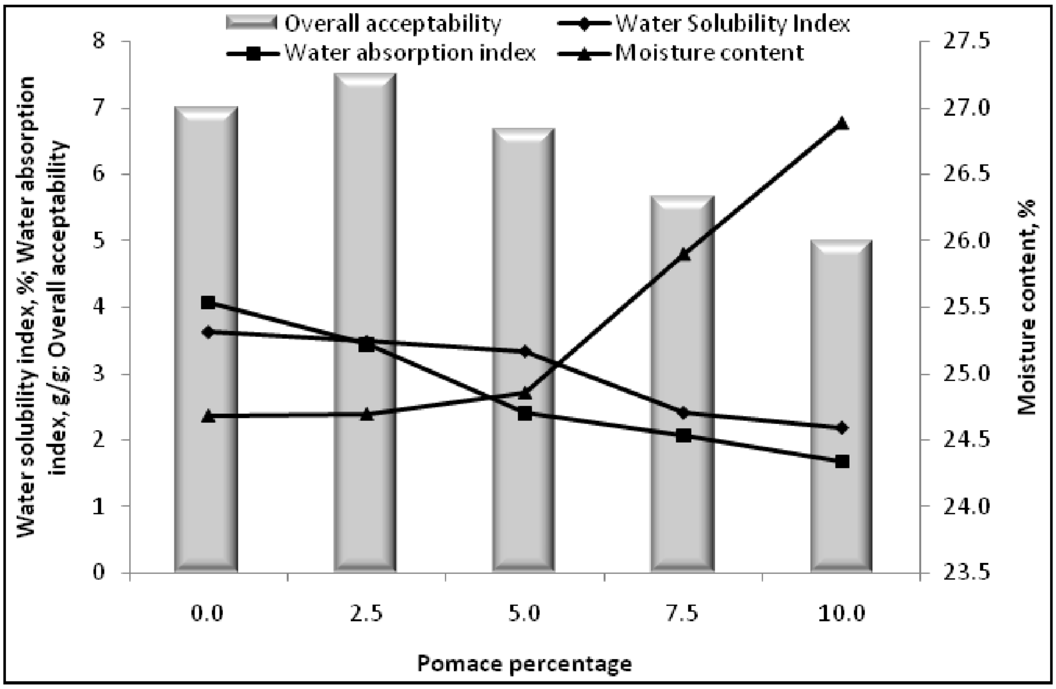

Fig. 2: Variation in WSI, WAI, Moisture Content and Overall Acceptability due to increase in Pomace Proportion in fine Wheat Flour based Buns

3.4. Moisture Content

It can be noted from Table 1 and Fig. 2 that the moisture content increased with the increase in pomace proportion. The moisture content increased from 24.68% to 26.89%. The *F* values for moisture content was 0.57 against *F* critical value of 3.47 (Table 2), indicates the variation in moisture content was not significant (p<0.05). The moisture content of the buns increased with the increase in carrot pomace may be attributed to the decrease in starch proportion responsible for starch gelatinization and expansion. Therefore, the less amount of moisture content was involved in starch gelatinization.

3.5. Overall Acceptability

It can be noted from Table 1 and Fig. 2 that the overall acceptability increased initially and decreased further with the increase in pomace proportion. The score value above 5 indicates the buns prepared from ingredients were acceptable. The maximum score of 7.5 out of nine point scale, indicates that the bun prepared from 2.5% pomace proportion resulted as suggested proportion for the development of buns. The *F* values for overall acceptability 16.90 against *F* critical value of 3.47 (Table 2), indicates the variation in overall acceptability was significant (p<0.05).

3.6. Correlation of Responses and Pomace Proportion

It can be observed from Table 3 that expansion, water solubility and absorption index were having correlation coefficient about 0.95 with pomace proportion, indicates that these are negatively correlated to the pomace proportion, however bulk density was positive correlated with the pomace proportion. It can further be noted that overall acceptability was correlated with water solubility index and moisture content.

Table 3: Correlation Matrix for variation in Bun Attributes

	Pomace Proport.	Linear Expan.	Surface Expan.	Bulk Density	Water Sol. Index	Water Abso. Index	Moisture Content	Overall Accept.
Pomace Proport.	1.000							
Linear Expansion	-0.981	1.000						
Surface Expansion	-0.977	1.000	1.000					
Bulk Density	0.986	-0.985	-0.983	1.000				
Water Sol. Index	-0.945	0.874	0.867	-0.883	1.000			
Water Abso. Index	-0.979	0.979	0.978	-0.993	0.883	1.000		
Moisture Content	0.914	-0.835	-0.823	0.853	-0.965	-0.824	1.000	
Overall Accept.	-0.907	0.810	0.799	-0.867	0.956	0.855	-0.962	1.000

4. SUMMARY AND CONCLUSIONS

Product development was done by conventional method utilizing carrot pomace in the different proportions of (0, 2.5, 5, 7.5 & 10%). All the ingredients were mixed to obtain good consistency dough, Later on these were baked in hot air-oven (approximately at 177±2 ^{0}C) for up to 40 minutes to a golden brown colour. It was observed that the expansion, water solubility and absorption index decreased with the increase in pomace proportion, whereas bulk density and moisture content increase with the increase in pomace proportion. It was further noted that the expansion, water solubility and absorption index and bulk density were having correlation to the pomace proportion. It was found that the buns having 2.5% carrot pomace has higher acceptability as compare to other samples.

REFERENCES

[1] Kaur, S., Sarkar, B.C., Sharma, H.K. & Singh, C.; *"Response surface optimization of conditions for the clarification of guava fruit juice using commercial enzyme"*, Journal of Food Process Engineering, 10.1111/j.1745-4530.2009.00414, 2009.

[2] Kumar, N., Sarkar, B.C. and Sharma, H.K.; *"Mathematical modelling of thin layer hot air drying of carrot pomace"*, Journal of Food Science and Technology, DOI 10.1007/s13197-011-0266-7, 2011.

[3] Kumar, N., Sarkar, B C. & Sharma, H.K.; *"Effect of Air Velocity on Kinetics of Thin Layer Carrot Pomace Drying"*, Food Science and Technology International, Vol. 17(5), pp. 459-

469. DOI: 10.1177/1082013211398832, 2011.

[4] Kumar, N., Sarkar, B.C. & Sharma, H.K.; *"Development and characterization of extruded carrot pomace and rice flour based product*", International Journal of Food Engineering, Vol. 6(03), Article 7, 2010.

[5] Kumar, N., Sarkar, B.C. and Sharma, H.K.; "*Development and characterization of extruded product using carrot pomace, pulse powder and rice flour*", African Journal of Food Science, Vol. 4(11), pp. 703–717, 2010.

[6] Kumar, N. and Kumar, K.; "*Development of Carrot Pomace and Wheat Flour Based Cookies*", Journal of Pure and Applied Science and Technology, Vol. 1(1), pp. 5-11, july 2011.

[7] Ranganna S.; *"Handbook of analysis and quality control for fruits and vegetable products"*, Tata Mc Graw Hill Publishing Company Limited, New Delhi, 1995.

[8] Anderson, R.A., Conway, H.F. & Griffin, E.L.; *"Gelatinization of corn grits by roll and extrusion cooking"*, Cereal Science Today, Vol. 14, pp. 4–12, 1969.

[9] Yagci, S. & Gogus, F.; *"Response surface methodology for evaluation of physical and functional properties of extruded snack foods developed from food-by-products",* Journal of Food Engineering, Vol. 86, pp. 122–132, 2008.

[10] Stojceska, V., Ainsworth, P., Plunkett, A., Ibanoglu, E. & Ibanoglu, S.; *"Cauliflower by-products as a new source of dietary fibre, antioxidants and proteins in cereal based ready-to-eat expanded snacks*", Journal of Food Engineering, Vol. 87, pp. 554–563, 2008

[11] Mason, W.R., & Hoseney, R.C.; *"Factors affecting the viscosity of extrusion-cooked wheat starch",* Cereal Chemistry, Vol. 63, pp. 436-441, 1986.

[12] T. Srikanth, A.D., Sarkar, B.C., Sharma, H.K. & Kumar, N.; *"Modeling and characterization of blended guava pomace and pulse powder based rice extrudates"*, International Journal of Food Engineering, MS-2366 (in press), 2011.