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Development and evaluation of calcium fortified date bars from indigenous sources

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Abstract

Calcium (Ca^+) is one of the most important minerals which is required by human body to sustain and construct strong teeth and bones. Also, calcium plays a vital role in proper working of the cardiac nerves, regulation of blood pressure and stretching and relaxing of muscles. The deficiency of calcium could lead to week teeth and bones and many conditions like osteoporosis and osteopenia. The purpose of the study was to develop calcium fortified bars. Chicken eggshell powder and calcium carbonate were used as main source of calcium. All the necessary ingredients were procured from local market Faisalabad. Calcium fortified bars were prepared with different percentage of calcium with respect to DRI value (50 %, 60 % and 75 %). All the raw material was analyzed for proximate composition following standard methods of AOAC. The bars were evaluated for proximate composition and mineral profile following the standard methods of AOAC (2006). It was observed that chicken egg-shell powder is an excellent source of various minerals including Nitrogen (0.542 ± 0.01), Calcium (37.7 ± 0.12), Magnesium (0.29 ± 0.01), Phosphorus (0.202 ± 0.00), Potassium (0.077 ± 0.00), Sodium (0.13 ± 0.00) and Carbonate (36.8 ± 0.02).All the bars were found to be shelf stable. It was concluded in current study that egg shell powder could be used as an alternate of calcium carbonate for development of calcium fortified bars.

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Introduction

Calcium is one of the very important minerals required by human body for normal functioning. 2 % of body weight embraces of this indispensable nutrient. Out of total Ca, about 99 % stored in skeleton and remaining 1 % stored in teeth and tissues in the body.

It plays important roles in body including, conduction of nerves, contraction of muscles and clotting of blood. If the amount of Ca in the blood serum reduces from its normal level then body sustained it through riveting from bones (Houtkooper and Farrell, 2004).

Deficiency of Ca and Vitamin D linked with number of lingering diseases like diseases of bones, kidney and many other long lasting autoimmune and inflammatory diseases (Peterlik and Cross, 2005).

Insufficient consumption, lower absorption, enhanced elimination through urinary tract of Ca, resistance in vitamin D, hypovitaminosis D leads towards hypocalcemia, along this number of factors leads towards hypoparathyroidism or secondary hyperparathyroidism (Thakker, 2006). Body stabs to overcome the hypocalcemia by increasing the absorption of Ca (Ensrud *et al.*, 2000). Although fractional absorption of Ca lowers down with the increased consumption of Ca (Heaney *et al.*, 2000).

Elimination of Ca through urinary system may enhanced by the consumption of those diet which contain greater amount of protein or sodium deficiency of a hormone known as estrogen and loop diuretics (Kerstetter *et al.*, 2003).

Consumption of Ca has been considered as a significant basis of health of bone (Braam *et al.*, 2003). Females who have been faced post-menopausal Ca intrusion resulted a bone parsimonious consequence by sequential extent of bone build (Heaney, 2001). Nonetheless, personally-preferred consumptions of Ca endure mostly under suggested echelons for females of wholly eternities (Montomoli *et al.*, 2002).

Products from natural sources are being used from thousands of years (Ranjha*et al.*, 2020). Eggshell of chicken is the chief source of Ca that is easily accessible at home and used as Ca supplement. Many studies on eggshell as Ca supplement showed that it is very efficient source of Ca without effecting body (Omi and Ezawa, 1998). In developing countries solid waste management is very deprived.

It is very obligatory to create a suitable pathway to transmute the eggshell that has been wasted into a valued underdone material which is helpful in many ways like provide financial benefits to many industries, also reduces cost of disposal and also lowers environmental hazard (Mac Neil, 2006).

Eggshell is useful material and used in many things like as a coating pigment in ink-jet printing (Yoo *et al.*, 2009), as a chief source of Ca in human and animal (Schaafsma *et al.*, 2000). Eggshell contain calcium carbonate, magnesium carbonate, calcium phosphate and organic matter of about 94 %, 1 %, 1 % and 4 % respectively. It is also free from Mercury, Aluminium and Cadmium, that's why it is safe for usage (Murakmi *et al.*, 2007).

Ca fortified cereal bars is an achievable method to overcome the Ca deficiency in women. Those women who takes two Ca fortified cereal bars per day for three weeks have clear increase in their Ca (Lee, 2015). In 2012, in the United States (US) totaled $3.7 billion for the sales of snacks bars and cereals bars.The demand for this food group increased due to customer attention in health, extensive trade delivery of cereal bars, increase of snack culture and convenience (Mintel, 2013).

Materials and methods

This study involved the development and evaluation of egg-shell Ca^{+} enrich bars.

Procurement of materials

Commercially available chicken eggs, good quality dates, almonds, peanuts, sesame seeds and honey were purchased from local market in Faisalabad.

Preparation of egg-shell powder

Chicken eggshell was collected, de-membraned, thoroughly washed under running tap water, scrubbed with a domestic sponge and then immersed in a solution of 10 drops of sodium hypochlorite (domestic bleaching agent) per liter of tap water rinsed, dried with paper towels and ground to powder. Then, it was passed through 0.18 mm sieve, dried in an oven at 80 °C until a constant weight is observed. Eggshell powder is sterilized in an autoclave at 121 °C for 15 minutes before use.

Product development

Bars were prepared by using egg shell powder and $CaCO_3$ at 50% RDA for Ca^+ by adding ESP and $CaCO_3$ with other ingredients. Ingredients used are given in Table 1. Treatment plan is given in Table 2.

Sensory evaluation

The sensory evaluation of different treatments of bars for various attributes including color, flavor, taste and overall acceptability was carried out by using 9 points hedonic scores systems as described by Meilgaard*et al.* (2007).

Proximate analyses

All ingredients, different treatments of bars were analyzed for proximate composition as follows:

Moisture content (%)

Moisture content of ingredients, different treatment of bars was determining through Drying Oven with Natural Convection (Model: ED – 115) Binder, Germany according to the procedure given by AOAC (2012).

Crude protein (%)

All ingredients, different treatments of bars were tested for crude protein content according to the method No. 46 – 10 through Kjeldhal (Model: BS – 207), QUICKFIT, England according to the method as described in AOAC (2012).

Crude fat (%)

The crude fat in all materials and bars was determined by running sample through Soxhelet apparatus [Model: CX7/ 06 (condenser), EX5/ 63 BS 2071 (siphon tube), FR 250 (collecting flask)], QUICKFIT, England (AOAC, 2012).

Crude fiber (%)

The crude fiber in all materials and bars was estimated according method outlined in AOAC (2012).

Total ash content (%)

Ash is the organic residues that remained after the material was completely brunt at a temperature of 550 °C in Muffle Furnace Automatic Digital Control, Pakistan. The ash content of all materials and bars was determined according to method described in AOAC (2012).

Mineral profile

Mineral content of product (Ca^+, Mg^+, P^+, K^+, Fe^+ and Zn^+) was analyzed by following the methods as described in AOAC (2012).

Statistical analysis

The collected data was subjected to be analyzed statistically using MiniTab 18.0. Analysis of Variance (ANOVA) and LSD tests were performed in order to seed the level of significance.

Results and discussion

Analysis of raw material

Date pulp: The proximate composition of date pulp is given in Table 3. It can be seen from the table that the date pulp contained moisture (17.32 ± 0.31), crude protein (3.45 ± 0.79), ash (2.17 ± 0.06), crude fat (0.73 ± 0.01), crude fiber (4.12 ± 0.03) and NFE (72.21 ± 0.11).

The proximate composition of date pulp shows that dates are mature and good for preparation of bars.In a parallel study by Jamil *et al.*, (2010) the proximate composition from Aseel variety of dates was determined as moisture content (%) 7.2±0.34, Ash/mineral content (%) 2.19±0.05, crude protein (%) 41.25±2.05, crude fat (%) 9.25±0.42, crude fiber

(%) 86.08±3.95 and NFE (%) 40.22±2.01.

Peanuts

The proximate composition of peanuts is given in Table 3. It can be seen from the table that the peanuts contained moisture (4.12 ± 0.02), crude protein (38.41 ± 0.91), ash (2.87 ± 0.02), crude fat (46.23 ± 0.97), crude fiber (3.19 ± 0.01) and NFE 5.18 ± 0.03.Atasie *et al*., (2009) determined the proximate analysis of peanut oil which encompassed crude fiber 3.70 %, content of ash 3.08 %, moisture content 5.80 %, fat 47.00 %Ozcan *et al*., (2003), protein 38.61 % and 1.81 % NFE.

Table 1. Quantity of raw material used for product development.

Ingredients	Quantity (g)
Dates	200
Peanuts	100
Almonds	100
Sesame seeds	80
Honey	20

Almonds

The proximate composition of almonds is given in Table 3. It can be seen from the table that the proximate composition of almonds is given as moisture (3.15 ± 0.02), crude protein (22.43 ± 0.91), ash (3.83 ± 0.02) and crude fat (45.21 ± 0.97). Agunbiade *et al*., (2006) observed the proximate analysis of almonds on the basis of assessment of nutritional factors reportedcrude fiber (%) 21.76±1.20, content of ash (%) 6.76±0.72 %, crude fat (%) 21.76±1.20, protein (%) 11.50±1.10 and carbohydrates (%) 54.87±2.80.

Table 2. Treatment plan.

Treatments	$CaCO_3$ (%) of RDA	Eggshell powder (%)
T_0	-	-
T_1	50	-
T_2	-	50

T_0 Placebo (serve as control that may provide 46 mg Ca)

T^1Commercial Calcium Fortified Bars that may provide 500 mg calcium

T^2 Indigenous Calcium Fortified Bars that may provide 500 mg calcium along with other minerals.

Sesame seeds

The proximate composition of sesame seedsis given in Table 3. As shown in table it can be seen that sesame seeds contained moisture (4.7 ± 0.01), crude protein (24.21 ± 1.03), ash(2.97 ± 0.01), crude fat (51.34 ± 1.34), crude fiber (3.17 ± 0.02) and NFE (13.61 ± 0.12).Adebowale *et al*., (2011) determined the quantities of proximate analysis of sesame seed up to moisture 5.7 %, ash 3.7 %, crude protein 20 %, fat 54 %, crude fiber 3.2 % and carbohydrate 13.4 %.

Honey

The proximate composition of honey is given in Table 3. It can be seen that the honey contained moisture (16.71 ± 0.14), crude protein (1.21 ± 0.01), ash (0.38 ± 0.00), crude fat (0.72 ± 0.00), crude fiber (0.00 ± 0.00), NFE (80.98 ± 1.03).Wasagu*et al*., (2013) reported the concentration of ash (%) 9.39 ± 0.15, moisture (%) 0.55± 0.05, crude fat (%) 1.51± 0.11, crude protein (%) 1.64± 0.06 and concentration of crude carbohydrate (%) 86.89± 0.93 of the light amber honey and ash (%) 13.03± 0.47, moisture (%) 0.68± 0.11, crude fat (%) 3.44± 0.42, crude protein (%) 1.87± 0.11 and NFE (%) 81.57± 0.47 for dark amber honey, respectively.

Mineral profile of egg shell powder

The egg shell powder was subjected to analysis for mineral composition through atomic absorption spectrophotometer and the results of the analysis are

given in Table 4. It was found egg shell powder contains nitrogen (0.542 ± 0.01 %), calcium (37.7 ± 0.12 %), magnesium (0.29 ± 0.01 %), phosphorus (0.202 ± 0.00 %), potassium (0.077 ± 0.00 %), sodium (0.13 ± 0.00 %), zinc (2.02 ± 0.00 ppm), manganese (13.06 ± 0.01 ppm), iron (1120 ± 4.5 ppm) and copper (0.96 ± 0.00 ppm). Klingen smith *et al.*, (1985) reported the mineral composition of HS (Hard-shelled) thicker shells of eggs had maximum contents of ash, magnesium, phosphorus and calcium as compared to SS shells (Soft-shelled) eggs.

Table 3. Proximate composition of raw materials used for preparation of bars.

Composition	Dates	Peanuts	Almonds	Sesame Seeds	Honey
Moisture	17.32 ± 0.31	4.12 ± 0.02	4.72 ± 0.03	4.7 ± 0.01	16.71 ± 0.14
Crude Protein	3.45 ± 0.79	38.41 ± 0.91	22.43 ± 0.07	24.21 ± 1.03	1.21 ± 0.01
Ash	2.17 ± 0.06	2.87 ± 0.02	3.83 ± 0.01	2.97 ± 0.01	0.38 ± 0.00
Crude Fat	0.73 ± 0.01	46.23 ± 0.97	48.21 ± 1.12	51.34 ± 1.34	0.72 ± 0.00
Crude Fiber	4.12 ± 0.03	3.19 ± 0.01	3.12 ± 0.01	3.17 ± 0.02	0.00 ± 0.00
NFE	72.21 ± 0.11	5.18 ± 0.03	17.69 ± 0.09	13.61 ± 0.12	80.98 ± 1.03

Analysis of bars

Moisture content

The bars were analyzed for moisture content at different storage intervals (0, 15, 30, 45 and 60 days).

The results of the moisture content at different storage intervals are given in table 5. A non-significant trend was observed for the moisture content at different storage intervals and treatments. A non-significant decrease in moisture content during storage interval was also observed in this study. The bars without calcium fortification had highest overall moisture content (17.66±0.02A) followed by bars fortified with egg shell powder (17.57±0.02AB) and bars fortified with calcium carbonate had lowest overall moisture content (17.54±0.02B). Nadeem *et al.*, (2012b) reported the level of moisture in date bar ranges between 15.56 ± 0.02 to 18.70 ± 0.02 %. Nadeem *et al.*, (2012) reported 19.21 % moisture in date bars.

Table 4. Mineral composition of egg shell powder.

Mineral	Egg shell powder
Calcium	39.62 ± 0.12 (%)
Magnesium	0.41 ± 0.01 (%)
Phosphorus	0.11 ± 0.00 (%)
Potassium	0.07 ± 0.00 (%)
Sodium	0.13 ± 0.00 (%)
Zinc	2.02 ± 0.00 (ppm)
Manganese	13.06 ± 0.01 (ppm)
Iron	1120 ± 4.5 (ppm)
Copper	0.96 ± 0.00 (ppm)

Crude protein

The bars were analyzed for crude protein content at different storage intervals (0, 15, 30, 45 and 60 days). The results of the crude protein content at different storage intervals are given in Table 5. A non-significant trend was observed for the crude protein content at different storage intervals and treatments. A non-significant increase in crude protein content during storage interval was also observed in this study. This non-significant increase in protein content could be because of decrease in moisture content of calcium fortified bars.

The bars with fortified with eggshell powder had highest overall crude protein content (12.16±0.01A) followed by bars without fortification (12.12±0.01B) and bars fortified with calcium carbonate had lowest overall crude protein content (12.03±0.01B).

Table 5. Effect of Treatments and Days on Proximate Composition of Calcium Fortified Bars.

Parameter	Days	Placebo	ESP	CaCO3	Overall (Days)
Moisture (%)	0	17.68±0.05A	17.59±0.05A	17.56±0.05A	17.61±0.03A
	15	17.68±0.04A	17.58±0.04A	17.55±0.03A	17.6±0.03A
	30	17.66±0.06A	17.57±0.06A	17.54±0.06A	17.59±0.04A
	45	17.66±0.06A	17.57±0.06A	17.53±0.06A	17.58±0.03A
	60	17.64±0.08A	17.56±0.09A	17.51±0.07A	17.57±0.04A
	Overall Means	17.66±0.02A	17.57±0.02AB	17.54±0.02B	
Crude Protein (%)	0	12.1±0.04A	12.15±0.03A	12.01±0.03A	12.10±0.02A
	15	12.12±0.03A	12.16±0.01A	12.03±0.02A	12.11±0.02A
	30	12.12±0.04A	12.16±0.01A	12.04±0.02A	12.11±0.02A
	45	12.12±0.02A	12.17±0.02A	12.04±0.02A	12.12±0.02A
	60	12.13±0.02A	12.17±0.01A	12.05±0.01A	12.13±0.02A
	Overall Means	12.12±0.01B	12.16±0.01A	12.03±0.01C	
Crude Fiber (%)	0	4.71±0.01A	4.65±0.01A	4.64±0.01A	4.67±0.01A
	15	4.71±0.01A	4.66±0A	4.65±0.01A	4.67±0.01A
	30	4.72±0.02A	4.67±0.02A	4.65±0.02A	4.68±0.02A
	45	4.73±0.02A	4.68±0.02A	4.66±0.02A	4.69±0.01A
	60	4.74±0.02A	4.67±0.04A	4.66±0.03A	4.69±0.02A
	Overall Means	4.72±0.01A	4.66±0.01B	4.65±0.01B	
Ash (%)	0	1.72±0.01C	3.55±0A	3.45±0.01B	2.90±0.37B
	15	1.73±0.01C	3.56±0A	3.45±0.01B	2.91±0.37AB
	30	1.73±0.01C	3.56±0.01A	3.46±0.03B	2.92±0.37AB
	45	1.73±0C	3.57±0A	3.46±0.01B	2.92±0.37AB
	60	1.74±0.01C	3.57±0.03A	3.47±0.01B	2.93±0.36A
	Overall Means	1.73±0C	3.56±0A	3.46±0.01B	
Crude Fat (%)	0	3.09±0.02A	3.04±0.01A	3.02±0.01A	3.05±0.01A
	15	3.1±0.01A	3.05±0.02A	3.03±0.01A	3.06±0.01A
	30	3.1±0.02A	3.05±0.02A	3.03±0.02A	3.06±0.02A
	45	3.11±0.02A	3.06±0.02A	3.04±0.02A	3.07±0.02A
	60	3.11±0.01A	3.06±0.02A	3.05±0.01A	3.07±0.01A
	Overall Means	3.1±0.01A	3.05±0.01B	3.03±0.01B	
NFE (%)	0	60.71±0.12A	59.02±0.1B	59.34±0.09B	59.67±0.31A
	15	60.67±0.09A	59±0.03B	59.29±0.08B	59.65±0.3A
	30	60.67±0.15A	58.99±0.05B	59.29±0.15B	59.64±0.31A
	45	60.66±0.04A	58.97±0.04B	59.28±0.04B	59.63±0.31A
	60	60.64±0.12A	58.96±0.06B	59.26±0.09B	59.61±0.3A
	Overall Means	60.65±0.04A	58.99±0.02C	59.27±0.03	

Means sharing different letters are statistically significant.

The concentration of crude protein in date bars was evaluated by Nadeem *et al.*, (2012) up to 10.85 %. Nadeem *et al.*, (2012b) recorded the crude protein from 7.41 ± 0.01 to 14.96 ± 0.01 %.

Crude fiber

The bars were analyzed for crude fiber content at different storage intervals (0, 15, 30, 45 and 60 days). The results of the crude fiber content at different storage intervals are given in Table 5. A non-significant trend was observed for the crude fiber content at different storage intervals and treatments. A non-significant increase in crude fiber content during storage interval was also observed in this study. This non-significant increase in fiber content could be because of decrease in moisture content of calcium fortified bars.

The bars without calcium fortification had highest overall crude fiber content (4.72±0.01A) followed by bars fortified with egg shell powder (4.66±0.01B) and bars fortified with calcium carbonate had lowest overall crude fiber content (4.65±0.01B). Nadeem *et al.*, (2012) examined the 6.14 % fiber quantity in date

bars. Nadeem*et al.*, (2012b) determined the crude fiber about 3.58 ± 0.01 to 3.91 ± 0.02 %.

Ash

The bars were analyzed for ash content at different storage intervals (0, 15, 30, 45 and 60 days). The results of the ash content at different storage intervals are given in Table 5. A non-significant trend was observed for the ash content at different storage intervals but a significant trend was observed among different treatments. A non-significant increase in ash content during storage interval was also observed in this study. This non-significant increase in ash could be because of decrease in moisture content of calcium fortified bars. The bars without calcium fortification had lowest overall ash content (1.73±0B) followed by bars fortified with calcium carbonate (3.46±0.01A) and bars fortified with egg shell powder had highest overall ash content (3.56±0A). Nadeem *et al.*, (2012) determined 4.20 % ash content availability in date bars. Nadeem*et al.*, (2012b) reported ash concentration about 2.30 ± 0.01 to 2.91 ± 0.02 %.

Table 6. Effect of treatment and days on calcium content of bars.

Days	Placebo	ESP	CaCO3	Overall (Days)
0 Days	47.21±0.00B	518.36±0.05A	511.68±0.05A	359.06±270.09A
15 Days	47.20±0.01B	518.39±0.04A	512.71±0.03A	359.44±270.41A
30 Days	47.23±0.01B	518.41±0.06A	512.75±0.06A	359.46±270.43A
45 Days	47.22±0.02B	518.44±0.06A	513.78±0.06A	359.81±270.72A
60 Days	47.19±0.01B	518.47±0.09A	515.81±0.07A	360.5±271.31A
Overall (Products)	47.21±01B	518.4±0.06A	513.35±1.4A	

Crude fat

The bars were analyzed for crude fat content at different storage intervals (0, 15, 30, 45 and 60 days). The results of the crude fat content at different storage intervals are given in Table 5. A non-significant trend was observed for the crude fat content at different storage intervals and treatments. A non-significant increase in crude fat content during storage interval was also observed in this study.

This non-significant increase in fat content could be because of decrease in moisture content of calcium fortified bars. The bars without calcium fortification had highest overall crude fat content (3.1±0.01A) followed by bars fortified with egg shell powder (3.05±0.01B) and bars fortified with calcium carbonate had lowest overall crude fat content (3.03±0.01B). Nadeem *et al.*, (2012) reported the quantity of crude fat in date bars upto 7.32 %. Nadeem *et al.*, (2012b) reported the fat ranged upto 5.55 ± 0.02-8.37 ± 0.01 %.

NFE (nitrogen free extracts)

The bars were analyzed for NFE content at different storage intervals (0, 15,30, 45 and 60 days). The results of the NFE content at different storage intervals are given in Table 5. A non-significant trend was observed for the NFE content at different storage intervals and treatments. A non-significant decrease in NFE content during storage interval was also observed in this study.

The bars without calcium fortification had highest overall crude NFE content (60.65±0.04A) followed by bars fortified with calcium carbonate (59.27±0.03B) and bars fortified with egg shell powder had lowest overall NFE content (58.99±0.02B). The content of NFE in date bars was reported as 71.49 % by Nadeem *et al.*, (2012). Nadeem *et al.*, (2012b) recorded the NFE quantity ranges from 70.85 ± 0.02 to 81.12 ± 0.07 %.

Mineral content of the bars

The bars were analyzed for Calcium content at different storage intervals (0, 15, 30, 45 and 60 days). The results of the Calcium content at different storage intervals are given in Table 6. A non-significant trend was observed for the calcium content at different

storage intervals but a significant trend was observed for calcium content among different treatments of bars. A non-significant increase in calcium content during storage interval was also observed in this study. The bars without calcium fortification had lowest overall calcium content (47.21±01B) followed by bars fortified with calcium carbonate (513.35±1.4A) and bars fortified with egg shell powder had highest overall calcium content (518.4±0.06A).

Table 7. Effect of treatment and days on sensory properties of bars.

	Days	Placebo	ESP	CaCO3	Overall
Color	0	7.9±0.68A	7.6±0.82AB	7.6±0.82AB	7.7±0.76A
	15	7.4±0.42AB	7.4±0.42AB	7.2±0.52ABC	7.33±0.45AB
	30	6.8±1.03ABC	7.1±0.97ABC	6.9±1.16ABC	6.93±1.03BC
	45	6.4±1.03BC	6.7±0.99ABC	6.6±1.05ABC	6.56±1CD
	60	6.3±1.25BC	6.4±0.92BC	5.8±1.03C	6.16±1.07D
	Overall	6.96±1.08A	7.04±0.93A	6.82±1.09A	
Taste	0	7.4±0.79ABC	7.7±0.88AB	8.1±0.85A	7.73±0.86A
	15	6.9±0.48ABCD	7.5±0.57AB	7.3±0.48ABCD	7.23±0.56AB
	30	6.6±0.94BCD	7.1±1.18ABCD	7±1.08ABCD	6.9±1.06B
	45	6.5±1.29BCD	6.4±0.92BCD	6.9±1.06ABCD	6.6±1.08BC
	60	6±1.17CD	5.9±1.16D	6.5±0.99BCD	6.13±1.11C
	Overall	6.68±1.05B	6.92±1.15AB	7.16±1.03A	
Flavor	0	7.4±0.92AB	7.6±0.94AB	7.8±0.92A	7.6±0.91A
	15	7.1±0.53ABC	7.3±0.48AB	6.9±0.48ABC	7.1±0.51AB
	30	7±0.52ABC	6.8±0.79ABC	6.8±0.79ABC	6.86±0.69B
	45	6.8±0.92ABC	6.5±0.99BC	6.5±0.74BC	6.6±0.87BC
	60	6.4±1.14BC	5.9±1.06C	5.9±0.82C	6.06±1.01C
	Overall	6.94±0.87A	6.82±1.04A	6.78±0.96A	
Texture	0	7.6±0.82AB	7.8±0.92A	7.8±0.92A	7.73±0.86A
	15	7.1±0.53ABC	7.3±0.48AB	7.1±0.53ABC	7.16±0.5AB
	30	6.9±0.68ABC	6.9±0.48ABC	6.8±0.92ABC	6.86±0.69B
	45	6.6±1.05ABC	6.6±0.82ABC	6.5±1.1ABC	6.56±0.96BC
	60	6.4±0.79BC	6.4±0.92BC	5.9±1.25C	6.23±1C
	Overall	6.92±0.87A	7±0.88A	6.82±1.13A	
Overall Acceptability	0	7.7±0.74A	7.5±0.88AB	7.8±0.79A	7.66±0.79A
	15	7.3±0.48AB	7.4±0.42AB	7.1±0.53AB	7.26±0.48AB
	30	6.9±0.68AB	7±1.08AB	6.9±1.25AB	6.93±0.99BC
	45	6.6±0.82AB	6.5±1.1AB	6.6±1.25AB	6.56±1.03C
	60	6.4±0.79AB	6.1±1.43B	6.4±1.03AB	6.3±1.09C
	Overall	6.98±0.83A	6.9±1.13A	6.96±1.08A	

Sensory evaluation of bars

All the treatments of the bars were subjected to be evaluated for sensorial properties (including color, taste, flavor & overall acceptability) at different storage intervals of 0, 15, 30, 45 and 60 days. The results of the sensory evaluation for different treatments at different storage intervals is given in Table 7. All the treatments of the bars were articulated be acceptable for sensorial properties at storage interval of 60 days.

The current study was conducted in order to see if egg shell powder could be used as an alternate source of calcium for calcium carbonate. The findings from current study conclude that egg shell powder could be a potential source for calcium. It was also concluded that the calcium fortified bars are shelf stable and no significant changes were observed during the storage

intervals. It was also concluded that all the treatments of the bars were accepted at al storage intervals for various sensorial properties including color, flavor, taste and overall acceptability.

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