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Effect of emmer wheat (*Triticum dicoccum*) semolina on nutritional composition, sensory attributes and textural characteristics of instant dessert (Halwa) mix

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Abstract
The study focuses on the sensory, physical, proximate, mineral, and textural evaluations of an instant dessert mix (halwa) formulated with varying proportions of common wheat semolina and emmer wheat semolina. Sensory analysis, conducted using a 9-point hedonic scale, revealed that the incorporation of emmer wheat semolina significantly influenced the colour, texture, and taste of the halwa. The selected sample (T_2) sample, comprising 23.8% common wheat semolina and 23.8% emmer wheat semolina, exhibited the highest overall acceptability score (8.6) compared to the control (T_0) score of 7.5.
Physical properties assessment demonstrated substantial differences between T_0 and T_2, with the latter exhibiting lower bulk density (0.19 g/ml), tapped density (0.24 g/ml), and higher compressibility (22.09%) and true density (0.68 g/ml). Proximate composition analysis per 100 grams showed T_2 having higher fat (7.25%) and protein (10.26%) content compared to T_0 (6.28% fat, 7.16% protein). Mineral composition revealed increased levels of iron, copper, zinc, manganese, and sodium in T_2, while calcium, potassium, and phosphorus levels remained stable.
Colour characteristics analysis displayed slight differences between T_0 and T_2, with T_2 exhibiting a slightly lighter colour and less intense yellow hue. Textural analysis of prepared halwa cubes showed T_2 to be significantly harder (7.65 N), more adhesive (-0.135 N·s), cohesive (3.33), springy (1.48), gummier (25.50 N), and chewier (37.58 N·s) compared to T_0. The statistical analysis revealed significant differences between formulations, with p-values less than 0.05.
The findings indicate that the incorporation of emmer wheat semolina positively influences the sensory attributes, physical properties, nutritional composition, mineral content, colour characteristics, and textural properties of the instant dessert mix, offering potential improvements in overall product quality. These results provide valuable information for the food industry in optimizing formulations to meet consumer preferences and nutritional requirements.

Keywords: Instant dessert mix, halwa, emmer wheat semolina, proximate, textural

1. Introduction
Wheat, a fundamental cereal crop, holds immense significance in global agriculture and human nutrition. In the context of India, where it is a staple, the challenges of meeting the increasing demand for wheat, especially given the critical role it plays in providing essential nutrients, pose a significant concern. The country, as the second-largest wheat producer worldwide, faces the intricate task of maintaining food security amid a growing population [1].
The significance of wheat in the Indian diet goes beyond mere sustenance, as it provides over two-thirds of the required iron and about one-third of the necessary calcium for adults, particularly in lower socio-economic groups [2]. The adaptability and high yield potential of wheat, combined with the unique visco-elastic properties conferred by the gluten protein fraction, make it a versatile crop used in various food products globally. *Triticum aestivum*, commonly referred to as the "king of cereals" or "golden grain," dominates global wheat production, constituting approximately 95 percent of the total output [3].
Research efforts have been directed towards understanding the nutritional composition, health benefits, and diverse applications of emmer wheat, including its use in craft beer production [4]. Among the various wheat varieties, Emmer wheat (*Triticum dicoccum*), an ancient grain, has garnered attention for its unique nutritional composition and potential

health benefits. Traditionally known as Khapli wheat in certain regions of India, its cultivation is prominent in states like Karnataka, Maharashtra, and Tamil Nadu, contributing to approximately 1% of the country's total wheat production [5]. Emmer wheat stands out due to its adaptability to poor soil conditions, resilience against fungal diseases, and the ability to thrive in mountainous regions.

Globally, the demand for wheat remains high, with wheat-based products serving as a major source of dietary energy and nutrients for a significant portion of the world's population [6]. Emmer wheat, with its rich nutritional composition, including higher protein content compared to common wheat varieties, presents an opportunity to diversify food product options [7].

In recent times, there has been a growing interest in the development of convenient, ready-to-cook food products, driven by changing lifestyles and the need for quick, healthy, and diverse meal options [8]. Instant dessert mixes, such as halwa, have gained popularity, offering a balance between convenience and nutritional value. The incorporation of Emmer wheat semolina into instant dessert mixes could potentially enhance the nutritional profile and sensory attributes of the final product.

By evaluating the unique qualities of emmer wheat in an instant dessert mix, this study seeks to contribute to the understanding of the potential applications of ancient wheat varieties in contemporary food products, promoting sustainable agriculture practices and diversifying food choices. The exploration of emmer wheat's impact on the nutritional, sensory, and textural aspects of the instant dessert mix is crucial for developing innovative and culturally relevant food products that cater to evolving consumer preferences.

2. Materials and Methods

2.1 Sample collection

The Emmer wheat (*Khapli* wheat) and common wheat were collected from the Wheat and Maize Research Unit, VNMKV, Parbhani, Maharashtra. The wheat grains collected were processed into semolina at the Department of Food Process Technology, College of Food Technology, VNMKV, Parbhani, using a flour mill.

Raw materials for the current study were acquired from the local market in Parbhani (MH), including dry fruits, cardamom, and sugar. The majority of the chemicals and equipment employed in this research were of analytical grade and sourced from the College of Food Technology, VNMKV, Parbhani.

2.2 Physical properties of Instant Dessert Mix

Bulk density, true density, compressibility index and angle of repose of instant mix was determined by the method of Sunil *et al*. [9]. Tapped density was assessed by tapping a known quantity of instant mix in a graduating cylinder 150 times [10].

2.3 Proximate composition of Instant Dessert Mix

The proximate analysis of the samples involved determining moisture content, fat, protein, crude fibre and carbohydrates using the AOAC [11] method, whereas ash content was determined by the method given by AOAC [12].

2.4 Mineral composition of Instant Dessert Mix

Mineral analysis of the samples involved ash moistening with glass-distilled water, addition of concentrated HCl, evaporation to dryness, and subsequent filtration for estimation of iron, copper, zinc, manganese, potassium, phosphorous, sodium, and calcium using various techniques, including atomic absorption spectroscopy, flame photometric method, spectrophotometric method, and titrimetric determination [13].

2.5 Colour characteristics of Instant Dessert Mix

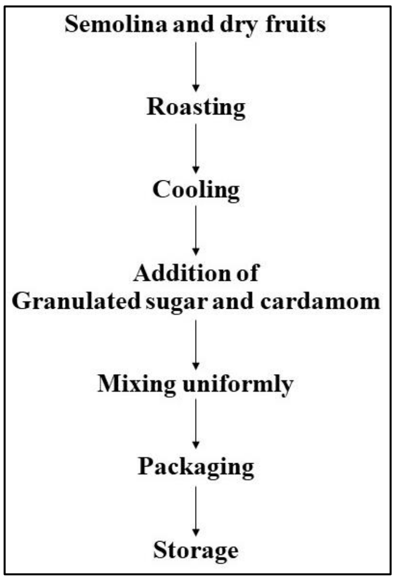
Color analysis of the instant mix was conducted using a Hunter Lab Colour Flex 45/0 optical sensor calibrated against a standard light yellow-colored reference tile (L* = 77.14, a* = 1.52, b* = 21.88), with L*, a*, and b* values measured to assess lightness, redness, and yellowness; L* representing lightness on a scale from 0 (black) to 100 (pure whiteness), a* indicating red (+) or green (-) color, and b* denoting yellow (+) or grey (-) color, and this analysis was performed at the Department of Horticulture, VNMKV., Parbhani [14].

2.6 Textural characteristics of prepared instant halwa cubes

Texture analysis of the halwa cubes was conducted using a Stable Micro Systems texture analyzer (Model TA XT2i, Surrey, England) with a two-cycle compression test. The halwa cubes (10 mm × 10 mm × 10 mm) were compressed by a 7.5 cm diameter plate at a rate of 2 mm/s to achieve a total deformation of 3 mm (70% compression), and different attributes such as hardness, adhesiveness, springiness, cohesiveness, gumminess, and chewiness were determined from the force–time curve recorded by the instrument [15].

2.7 Sensory Evaluation of Instant Dessert Mix

The sensory evaluation of different prepared instant halwa mix was conducted by a panel of semi-trained judges from the College of Food Technology, V.N.M.K.V., Parbhani, using a nine-point hedonic scale, ranging from 'like extremely' to 'dislike extremely' [16].



2.8 Flow chart for preparation of Instant Dessert Mix

2.9 Formulation of Instant Dessert Mix

Emmer wheat based Instant Dessert mix was prepared with varying the composition of selected ingredients including emmer wheat and common wheat semolina. Emmer wheat semolina was not included in the control sample of halwa mix. Five different formulations are presented in Table 1.

Table 1: Different Formulations of Instant Dessert Mix (Halwa)

Sample	Common wheat semolina (%)	Emmer wheat semolina (%)	Sugar (%)	Dry fruits (%)	Cardamom (%)
T_0	100	0	47.6	4	0.8
T_1	75	25	47.6	4	0.8
T_2	50	50	47.6	4	0.8
T_3	25	75	47.6	4	0.8
T_4	0	100	47.6	4	0.8

A series of formulations were developed for the Instant Dessert Mix (Halwa), altering the composition of key ingredients to create a range of variations. The primary components under consideration included common wheat semolina, emmer wheat semolina, sugar, dry fruits (almond and cashew nut), and cardamom. The control formulation, denoted as T_0, consisted of 100% common wheat semolina and omitted emmer wheat semolina entirely. In terms of sweetness, all formulations maintained a consistent 47.6% sugar content. Additionally, 4% of dry fruits, a combination of almonds and cashew nuts, were incorporated into each formulation, alongside 0.8% cardamom. The subsequent formulations, labeled T_1 through T_4, introduced different ratios of common wheat semolina and emmer wheat semolina, with T_1 featuring a 75% common wheat semolina and 25% emmer wheat semolina blend, T_2 adopting a 50-50 ratio, T_3 comprising 25% common wheat semolina and 75% emmer wheat semolina, and T_4 exclusively utilizing 100% emmer wheat semolina. These variations in ingredient composition aimed to explore the impact of wheat semolina types on the instant mix potentially yielding diverse sensory and nutritional profiles.

2.10 Statistical analysis
All analyses unless otherwise specified, were done in triplicate. Statistical significance was established using one-way analysis of variance (ANOVA), and data were reported as mean ± standard deviation. Mean comparison and separation were done using Tukey's test ($p<0.05$). Statistical analysis was carried out using the Jamovi 2.4.11 (https://www.jamovi.org/) software.

3. Results and Discussions
3.1 Sensory evaluation of Instant Dessert mix (Halwa)
Sensory evaluation of the instant dessert mix (Halwa) was carried out with the help of trained and semi-trained panel members using the 9-point hedonic scale. The parameters like appearance, colour, taste, flavour, texture, and overall acceptability were considered. The mean score of different organoleptic characteristics of the instant dessert mix (halwa) with the prepared product for the formulations is plotted in spider plot graphical representation as shown in Fig 1.

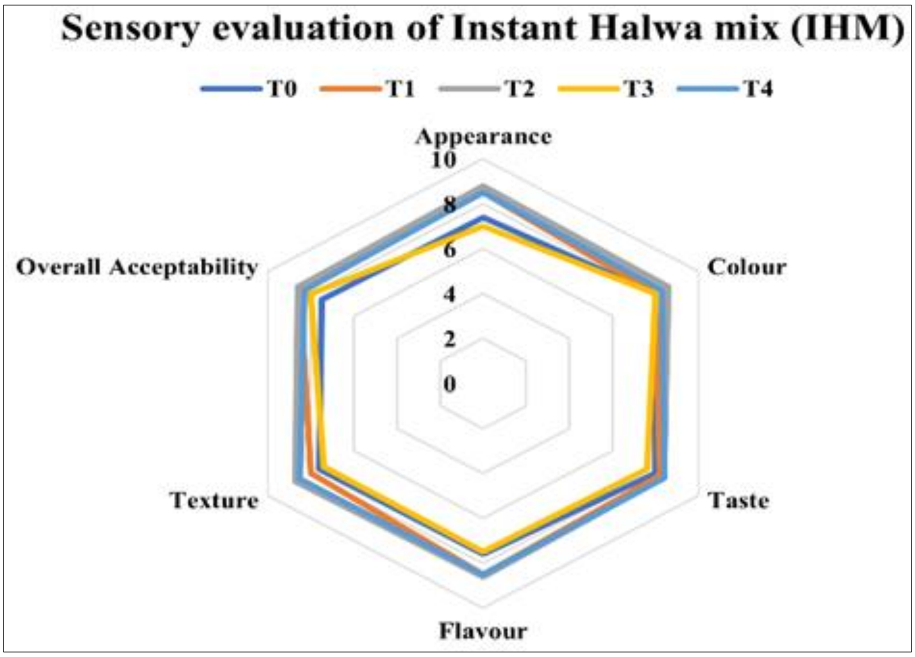


Fig 1: Sensory evaluation of Instant Dessert mix (Halwa)

Where,
T_0 (Control) – 47.6% common wheat semolina + 47.6% sugar + 4% dry fruits (almonds and cashew nuts) + 0.8% cardamom
T_1 - 35.9% common wheat semolina + 11.9% emmer wheat semolina + 47.6% sugar + 4% dry fruits (almonds and cashew nuts) + 0.8% cardamom
T_2 - 23.8% common wheat semolina + 23.8% emmer wheat semolina + 47.6% sugar + 4% dry fruits (almonds and cashew nuts) + 0.8% cardamom
T_3 - 11.9% common wheat semolina + 35.9% emmer wheat semolina + 47.6% sugar + 4% Dry fruits (almonds and cashew nuts) + 0.8% cardamom
T_4 - 47.6% emmer wheat semolina + 47.6% sugar + 4% dry fruits (almonds and cashew nuts) + 0.8% cardamom

Data presented in Fig. 1 revealed that there was a significant effect of the incorporation of emmer wheat semolina on colour, texture, and taste of halwa. Results revealed that there was the highest overall acceptability score (8.6) for the T_2 sample compared to control. For the parameters like appearance, colour, taste, flavour, and texture sample T_2 showed the highest score. Sample T_0 showed the lowest score for all the parameters with an overall acceptability score (7.5).

3.2 Physical properties of Instant Dessert Mix (Halwa)

The physical properties of the instant dessert mix (halwa) were examined for the selected sample (T_2) and compared with the control sample (T_0). Table 2 below presents various physical properties of instant mix such as bulk density, tapped density, compressibility, true density, and angle of repose. These properties are crucial in assessing the quality and behaviour of the halwa mix during processing and storage.

Table 2: Physical properties of Instant Dessert Mix (Halwa)

Parameters	Control (T_0)	Selected sample (T_2)
Bulk density (g/mkl)	0.43±0.12^a	0.19±0.03^b
Tapped density (g/ml)	0.45±0.09^a	0.24±0.04^b
Compressibility (%)	16.33±2.3^a	22.09±0.61^b
True density (g/ml)	0.55±0.04^a	0.68±0.03^b
Angle of repose (°)	37.19±1.22^a	41.47±1.60^b

Values expressed are average ±SD.
Means in the rows with different superscripts are significantly (p<0.05) different.

The bulk density of the T_0 sample was 0.43 ± 0.12 g/ml, which significantly higher (p<0.05) to 0.19 ± 0.03 g/ml in the selected sample. This decrease in bulk density indicates that the selected sample has a more loosely packed structure, potentially affecting its flowability and handling characteristics. The tapped density of the T_0 sample was 0.45±0.09 g/ml, which decreased to 0.24±0.04 g/ml in the selected sample. The decrease in tapped density further emphasizes the selected sample's reduced packing and compaction compared to the initial sample. Bulk density is a measure of the weight of flour. It is influenced by sample particle size and is critical for determining packing needs, material handling, and other uses in the food industry for wet processing [17].

The compressibility of the control. The compressibility of the T_0 sample (16.33±2.3%), differed significantly (p<0.05) from that of the selected sample (22.09±0.61%). This indicates that the selected sample is more compressible, possibly due to its reduced bulk and tapped densities. True density is another crucial parameter, and in the T_0 sample, it measured 0.55±0.04 g/ml, while in the selected sample, it increased to 0.68±0.03 g/ml, demonstrating a statistically significant difference (p<0.05). This suggests that the selected sample has a higher true density, indicating a more compact structure. The angle of repose, measured in degrees, went from 37.19±1.22° in the T_0 sample to 41.47±1.60° in the selected sample. The increase in the angle of repose indicates a steeper slope in the pile of the selected sample, potentially affecting its flow properties.

Similar results were exhibited for tomato powder, compressibility index of 22.78%, indicating its flowability characteristics, along with a bulk density of 0.45 g/ml, a tapped density of 0.58 g/ml, and an angle of repose of approximately 34.058° [18]. Similar results were also observed from the studies of the physical properties of the prepared instant upma mix [19].

3.3 Proximate composition of Instant Dessert Mix (Halwa)

The proximate composition of instant dessert mix (Halwa) is presented in Table 3. The Table provides information about the nutritional content of the product per 100 grams.

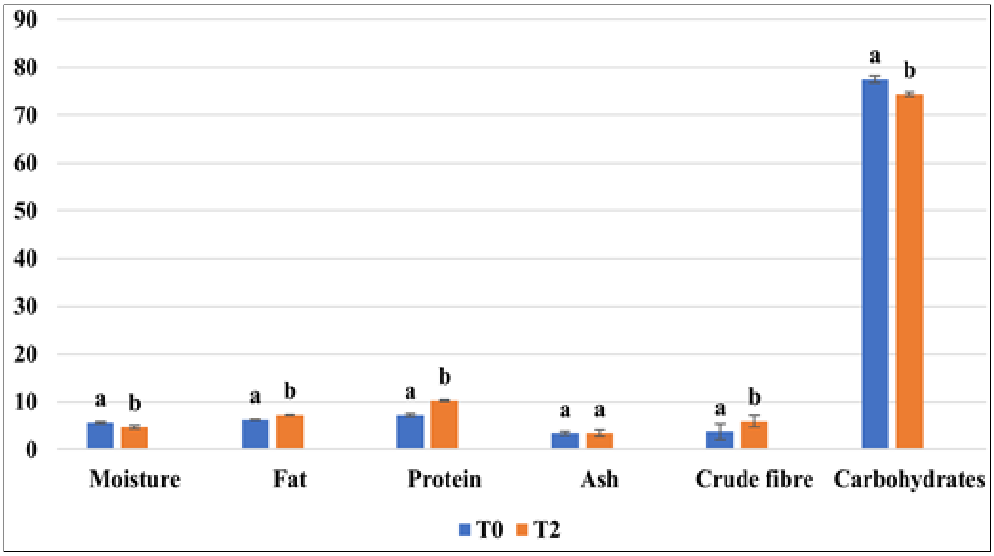


Fig 2: Proximate Composition of Instant Dessert Mix (Halwa)

The proximate composition of instant dessert mix (halwa) with two sets of samples per 100 grams, labelled as T_0 and selected sample T_2 are presented in Table 3. The moisture content for the T_0 sample was found to be 5.67±0.19, while the selected sample exhibited a significantly lower (p<0.05) moisture content of 4.67±0.38%. In terms of fat content, the T_0 value was found to be 6.28±0.02, whereas the selected sample demonstrated a higher fat content of 7.25±0.01% (p<0.05). The protein content in the T_0 sample was 18.5±0.26, contrasting with the selected sample, which exhibited a significantly higher (p<0.05) protein content of 10.26±0.20%. The decrease in protein solubility and percentage during roasting is primarily due to the denaturation and structural changes that proteins undergo when exposed to high temperatures. These changes render the proteins less soluble in various solvents, leading to a decrease in their solubility and a decrease in the perceived protein content in the roasted semolina [20].

Ash content displayed minimal variation between the samples, with the control group at 3.38±0.38% and the selected sample at 3.44±0.60%, demonstrating no significant difference (p>0.05). Notably, the crude fiber content was markedly higher in the selected sample as 5.99±1.20% compared to the control group as 3.75±1.65%, and this difference was found to be statistically significant (p<0.05). Lastly, the carbohydrate content in the control group was 77.49±0.70%, while the selected sample exhibited a slightly lower carbohydrate content of 74.37±0.41%, indicating a statistically significant difference (p<0.05). These values provide the nutritional composition of the instant mix, showcasing variations in moisture, fat, protein, ash, crude fiber, and carbohydrates between the T_0 reference and the selected sample. The increase in fat percentage observed when roasting wheat semolina is likely due to several factors related to the chemical changes that occur during the roasting process such as hydrolysis of bound lipids, release of volatile compounds and thermal degradation [20].

The proximate composition of instant halwa mix from composite flour showed similar values for moisture, protein, fat, crude fiber, ash, carbohydrates, and energy content [21]. The optimized instant halwa mix made from kodo millet flour contains approximately 83.5 g of total carbohydrates, 2.9 g of fat, 1.0 g of moisture, 12.1 g of protein, 0.5 g of ash, 79.28% of antioxidants, and 7.2 g of crude fiber per 100 g of the product [22].

3.4 Mineral Composition of Instant Dessert Mix (Halwa)

The mineral composition of instant dessert mix (halwa) was examined for two samples T_0 and T_2 and presented in Table 4. The mineral concentrations are measured in parts per million (ppm) and are reported with mean values and their respective standard deviations to account for variability. In both samples, several essential minerals were analyzed, including iron (Fe), copper (Cu), zinc (Zn), manganese (Mn), sodium (Na), calcium (Ca), potassium (K), and phosphorus (P).

Table 4: Mineral Composition of Instant Dessert Mix (Halwa)

Minerals	T_0	T_2
Iron (Fe)	2.44±0.29^a	4.60±0.54^b
Copper (Cu)	0.49±0.14^a	0.61±0.12^a
Zinc (Zn)	2.13±0.19^a	3.26±0.36^b
Manganese (Mn)	1.86±0.56^a	2.8±0.16^b
Sodium (Na)	4.47±0.05^a	5.07±0.03^b
Calcium (Cl)	48.12±0.23^a	49.30±0.15^b
Potassium (K)	254.35±0.57^a	255.55±0.07^b
Phosphorous (P)	219.74±0.73^a	217.32±0.53^b

Values expressed are average ±SD.
Means in the rows with different superscripts are significantly (p<0.05) different.

Notable differences were observed in several mineral concentrations. Iron content in T_2 (4.60±0.54 ppm) exhibited a significant higher value (p<0.05) compared to the control T_0 (2.44±0.29 ppm). Copper content displayed minimal variation between the samples, with the control group at 0.61±0.12 ppm and the selected sample at 0.49±0.14 ppm demonstrating no significant difference (p>0.05). Zinc concentration demonstrated a marked elevation from 2.13±0.19 ppm at T_0 to 3.26±0.36 ppm at T_2 (p<0.05), signifying a noteworthy increase. Manganese and sodium also show an increase in their concentrations in T_2 compared to T_0. Specifically, manganese levels increase from 1.86±0.56 ppm to 2.8±0.16 ppm, while sodium content rises from 4.47±0.05 ppm to 5.07±0.03 ppm, underscoring a distinct change (p<0.05).

The concentrations of calcium, potassium, and phosphorus remain relatively consistent between the control sample T_0 and the T_2 sample. Calcium content changes only slightly from 48.12±0.23 ppm to 49.30±0.15 ppm (p<0.05). Similarly, potassium levels show minimal variation but significant difference (p<0.05) with values of 254.35±0.57 ppm in T_0 and 255.55±0.07 ppm in T_2. Phosphorus content experiences a modest decrease from 219.74±0.73 ppm in T_0 to 217.32±0.53 ppm in T_2.

These observations suggest that the addition of emmer wheat semolina (T_2) has a notable impact on the mineral composition of the instant dessert mix (Halwa), particularly increasing the levels of iron, copper, zinc, manganese, and sodium, while calcium, potassium, and phosphorus levels remain relatively stable. The mineral composition of the prepared instant upma mix, as analyzed by Dhadke [19] showed an increase in mineral values from the control to a selected sample.

3.5 Colour characteristics of Instant Dessert Mix (Halwa)

The colour characteristics of instant dessert mix (halwa) were analyzed for the two samples, control sample (T_0), which consisted of 100% common wheat semolina, and the selected sample (T_2), which was a blend of 50% common wheat semolina and 50% emmer wheat semolina. Colour values were measured using the L*, *a**, b* colour space parameters, as well as chroma (C*) and hue angle (h*).

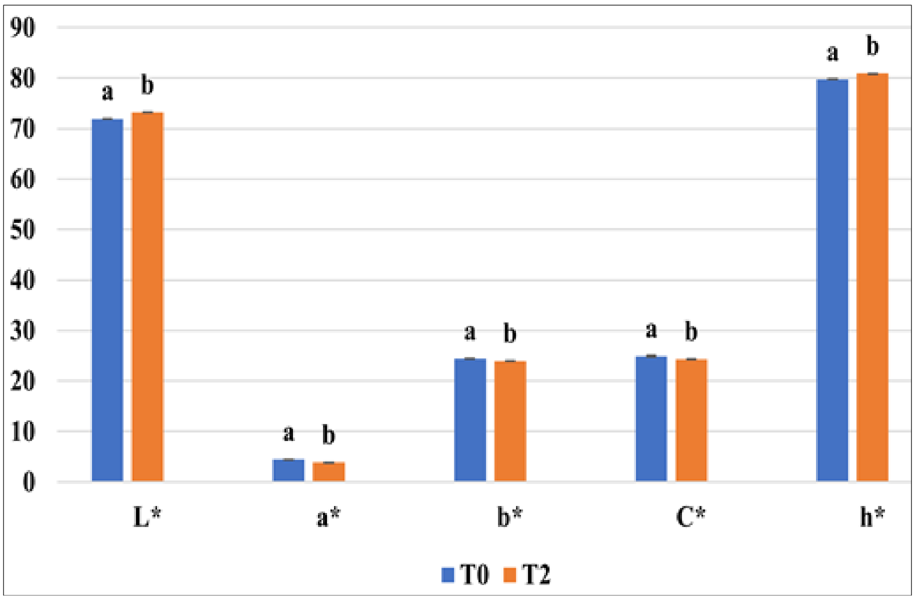


Fig 3: Colour Characteristics of Instant Dessert mix (Halwa)

The L* value for the control sample (T_0) was found to be approximately 71.95±0.02, indicating a relatively light colour. The a* value, which represents the green-to-red axis, was approximately 4.43±0.02, suggesting a slight reddish tint. The b* value, representing the blue-to-yellow axis, was approximately 24.40±0.02, indicating a predominantly yellow hue. The chroma (C*) value, which quantifies the colour intensity, was 24.9±0.15, indicating a moderate colour intensity. Lastly, the hue angle (h*) was approximately 79.73±0.05, signifying a colour leaning towards yellow.

In contrast, the selected sample (T_2) displayed slightly different colour characteristics. The L* value was measured at approximately 73.19±0.04, indicating a slightly lighter colour compared to the control sample. The a* value was slightly lower, at approximately 3.83±0.02, suggesting a slightly less pronounced reddish tint. The b* value was approximately 23.93±0.07, indicating a similar yellow hue but slightly less intense compared to the control sample. The chroma (C*) value was 24.31±0.02, showing a comparable colour intensity to the control sample. The hue angle (h*) was approximately 80.91±0.02, indicating a colour that still leaned towards yellow but was slightly shifted compared to the control. Statistical significance, as determined by the comparison of means, was established ($p<0.05$) for all colour parameters, signifying notable variations between the control and selected samples.

The analysis of the colour characteristics revealed subtle differences between the control sample (T_0) and the selected sample (T_2). While both samples exhibited light colours with a yellow hue, the selected sample showed a slightly lighter and less intense colour, with a minor shift in the hue angle. These findings provide valuable information on the colour profile of instant dessert mix (halwa) and the impact of incorporating emmer wheat semolina into the blend. Similar results of Hunter colour analysis of cooked upma formulations revealed L* values ranging from 55.53 to 64.01, a* values from 2.08 to 3.76, and b* values from 16.91 to 19.97 [23]. The colour properties of Sheera flour exhibited L*, a*, and b* values of 90.21, 0.953, and 8.52 respectively, while wheat flour had slightly lower values of 89.60, 0.965, and 8.92, with a ΔE value of 6.696 for Sheera and 6.849 for wheat flour [24].

3.6 Textural parameters of prepared halwa cubes

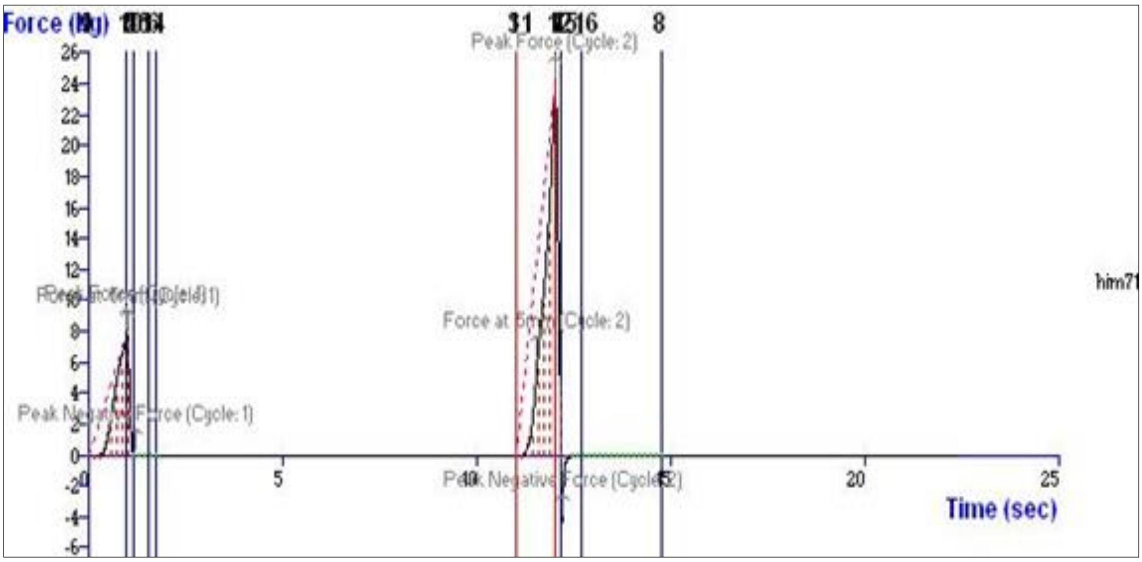
The textural parameters of two samples of prepared halwa cubes, labelled as T_0 and T_2 were determined and presented in Table 6. These parameters provide valuable information into the texture and mouthfeel characteristics of the halwa samples.

Table 6: Textural parameters of prepared halwa cubes

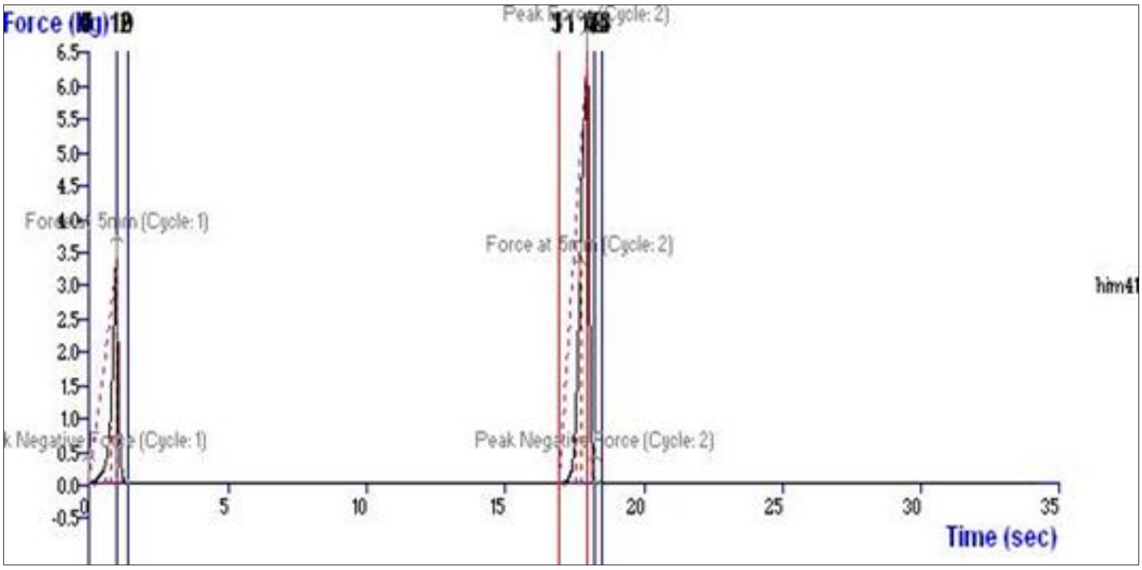
Textural properties	Samples	
	T_0	T_2
Hardness	3.16±0.129^a	7.65±0.24^b
Adhesiveness	-0.015±0.002^a	-0.135±0.001^b
Cohesiveness	1.83±0.769^a	3.33±0.80^b
Springiness	1.22±0.04^a	1.48±0.10^b
Gumminess	5.87±2.66^a	25.50±6.29^b
Chewiness	7.20±3.24^a	37.58±7.34^b

Values expressed are average ±SD.
Means in the rows with different superscripts are significantly ($p<0.05$) different.

The control sample (T_0) exhibited a hardness of 3.16 0.129, while the selected sample (T_2) demonstrated a significantly higher ($p<0.05$) hardness at 7.65±0.24. Adhesiveness, measured in terms of the negative force required to overcome the attractive forces between the food surface and the probe, displayed a notable difference between the two samples. T_0 recorded an adhesiveness of -0.015±0.002, whereas T_2 showed a substantially higher ($p<0.05$) adhesiveness of -0.135±0.001. Cohesiveness, indicative of the internal resistance of the sample to rupture, exhibited a discernible variation between T_0 (1.83±0.769) and T_2 (3.33±0.80). Springiness, denoting the ability of the sample to regain its original shape after compression, showed a significant difference as well. T_0 displayed a springiness of 1.22±0.04, while T_2 exhibited a higher springiness ($p<0.05$) of 1.48±0.10. Gumminess, calculated as the product of hardness and cohesiveness, was substantially higher ($p<0.05$) in T_2 (25.50±6.29) compared to T_0 (5.87±2.66). Similarly, chewiness, representing the energy required to masticate the sample, demonstrated a significant increase ($p<0.05$) in T_2 (37.58±7.34) in contrast to T_0 (7.20±3.24). Various textural attributes of the halwa samples are given in Fig.2.



a) Textural parameters of control sample (T_0)



b) Textural parameters of control sample (T_2)

Fig 4: Graphs of textural parameters of control sample (T_0) and selected sample (T_2)

The textural attributes of halwa samples made with different oils showed variations, with hardness ranging from 6 to 9 N, cohesiveness between 0.29 and 0.58, chewiness between 1.8 and 4.9 N-m, springiness between 0.38 and 0.85 mm, gumminess ranging from 3.5 to 9.8 N, and adhesiveness varying from -4.8 to -21.6 N-m, with olive oil halwa being significantly less adhesive compared to the other two samples [25]. Another study for the texture profile analysis of sandesh revealed the following textural attributes: hardness ranging from 3308 to 14459 g, fracture ability from 1885 to 11046 g, resilience from 0.014 to 0.025, cohesiveness from 0.041 to 0.069, springiness from 0.086 to 0.301, gumminess from 188.8 to 621.7 g, adhesiveness from 11.6 to 256.2 g·s, and chewiness from 16.2 to 179.7 g [26].

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4. Conclusions

The sensory evaluation of the instant dessert mix (Halwa) demonstrated that the incorporation of emmer wheat semolina (T_2) significantly enhanced the overall acceptability, taste, color, and texture compared to the control (T_0). Physical properties analysis revealed that T_2 exhibited lower bulk and tapped densities, higher compressibility, and increased true density, indicating changes in the structural characteristics of the halwa mix. Proximate composition analysis showed variations in moisture, fat, protein, crude fiber, and carbohydrates, with T_2 generally presenting higher fat and protein content. The mineral composition of T_2 exhibited increased levels of iron, copper, zinc, manganese, and sodium, while calcium, potassium, and phosphorus levels remained relatively stable. Color analysis revealed subtle differences between T_0 and T_2, with the latter exhibiting a slightly lighter and less intense color. Textural analysis indicated that T_2 had significantly higher hardness, adhesiveness, cohesiveness, springiness, gumminess, and chewiness compared to T_0. Overall, the incorporation of emmer wheat semolina in the halwa mix resulted in notable improvements in sensory, physical, nutritional, mineral, color, and textural characteristics.

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6. References
1. Joshi AK, Mishra B, Chatrath R, Ferrara GO Singh RP. Wheat improvement in India: present status, emerging challenges, and future prospects. Euphytica; c2007. p. 431-446.
2. Aykroyd WR, Doughty J. Wheat in human nutrition. FAO Nutrition Studies. 1970:23:1-163.
3. Dhanavath S, Rao U.J.S.P. Nutritional and Nutraceutical Properties of Triticum dicoccum Wheat and Its Health Benefits: An Overview. Journal of Food Science. 2017:82:2243-2250.
4. Mozzon M, Boselli E, Obiedziński M.W, Frega NG. Occurrence of biogenic amines in beers produced with malted organic Emmer wheat (*Triticum dicoccum*). Food Additives & Contaminants: Part A; c2015.
5. DACNET n.d. Status paper on wheat.
6. Laskowski W, Warsewicz HG, Rejman K, Czeczotko M, Zwolinska J. How Important are Cereals and Cereal Products in the Average Polish Diet? Nutrients. 2019;11:1-21.
7. Biel W, Jaroszewska A, Stankowski S, Sobolewska M, Pacelik JK. Comparison of yield, chemical composition and farinograph properties of common and ancient wheat grains. European Food Research and Technology. 2021;247:1525-1538.
8. Sundaram N. A market study on key determinants of Ready-to-Eat/cook products with respect to Tier-I cities in Southern India. ZENITH: International Journal of Multidisciplinary Research. 2012;2:168-180.
9. Sunil CK, Venkatachalapathy N, Shanmugasundaram S, Pare A, Loganathan M. Engineering properties of foxtail millet (*Setaria* italic): variety HMT 1001. Int. J. Sci., Environ. Technol. 2016;5: 632-637.
10. Ayadi MA, Abdelmaksoud W, Ennouri M, Attia H. Cladodesfrom *Opuntia ficus-indica* as a source of dietary fiber: effect on dough characteristics and cake making. Inds Crop Pro. 2009;30:40-47.
11. AOAC. Official method of analysis of the AOAC international. 18th Edn. Association of Official Analytical Chemists, Gaithersburg, MD; c2005.
12. AOAC. Official methods of analysis, Association of Official Analytical Chemists, Washington, DC; c1990
13. Ranganna S. Handbook of Analysis and Quality Control for Fruits and Vegetable Products. 2nd Edn. Tata McGraw Hill Publishing Company Ltd., New Delhi; c1986.
14. Kumar V, Sharma HK, Mishra S. Simulation of spray drying of tomato juice using computational fluid dynamics (CFD). Cogent Food Agric. 2017;3:1-9.
15. Rahman MS, Al-Farsi SA. Instrumental texture profile analysis (TPA) of date flesh as a function of moisture content. J. Food. Eng. 2005;66:505-511.
16. Meilgaard MC, Carr BT, Civille GV. Sensory evaluation techniques. CRC press; c1999.
17. Ocloo FCK, Bansa D, Boatin R, Adom T, Agbemavor WS. Physico-chemical, functional, and pasting characteristics of flour produced from Jackfruits (*Artocarpus heterophyllus*) seeds. Agric. Biol. J North. Amer. 2010;1:903-908.
18. Bhargavanandha KS. Studies on utilization of partially hydrolyzed guar gum in tomato soup powder (master's thesis). Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani; c2021.
19. Dhadke SG. Development and quality evaluation of popped sorghum based instant upma mix (Master's thesis). Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani; c2023.
20. Premavalli KS, Arya SS. Physical and chemical changes during roasting of semolina (Suji). Int. J. Food Sci Technol. 1983;18:469-479.
21. Duggal M. Development and evaluation of instant halwa mix from malted composite flour (Master's thesis). Centre of Food Science and Technology CCS Haryana Agricultural University Hisar; c2016.
22. Bharti P. Studies on the optimization and development of functional instant dry halwa mix using kodo millet and gram flour (Master's thesis). Centre of Food Science and Technology Institute of Agricultural Sciences Banaras Hindu University Varanasi; c2019.
23. Dhumketi K, Singh A, Agrawal P. Formulation and quality evaluation of modified upma mix from Foxtail millet and soy for nutritional security. Int. J Curr. Microbiol. Appl. Sci. 2018;7:888-896.
24. Singh C, Kumar V, Sharma M, Singh AK, Kumar A. Study of Physicochemical Properties of Fermented Wheat Flour (Sheera). 2019, 6.
25. Manickavasagan A, Al Hashmi RSS, Al Sulti ASA, Al-Sabahi JN, Al-Belushi RH, Rahman S, *et al*. Texture profile analysis (TPA) of Omani halwa while replacing ghee with vegetable oils. In: CSBE/SCGAB 2011 Annual Conference, Inn at the Forks, Winnipeg, Mb; c2011. p. 10-13.
26. Khamrui K, Solanki DC. The relationship of textural characteristics with composition of sandesh produced from various market milk classes. Int. J. Dairy. Technol. 2010;63:451-456.