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Comparative study of physicochemical and hedonic response of ginger rhizome and leaves enriched patties

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Abstract: The present investigation was an attempt to compare the phytoceutic potential of ginger rhizome and ginger leaves of the Suravi variety. For this purpose, both rhizome and leaves were dried and used for the preparation of patties. After that, patties were assessed for colour tonality, texture, total phenolic content and hedonic response such as colour, taste, flavour, texture and overall acceptability. The results depicted that *L** and *b** values changed significantly during the storage interval; however, *b** value was also affected by treatments whilst *L** and *a** values did not impart any momentous effect. For texture, the highest value was observed for patties with ginger rhizome powder (0.067 ± 0.0032 N) followed by patties with ginger leaf powder (0.060 ± 0.0029 N) and then control patties (0.057 ± 0.0026 N). For total phenolic content (TPC), maximum phenolic contents were observed as 84.80 ± 3.31 mg GAE 100 g^{-1} in treatment T_2 followed by 75.68 ± 2.95 mg GAE 100 g^{-1} in T_1 and 61.70 ± 2.41 mg GAE 100 g^{-1} in T_0. For hedonic response, all the parameters changed significantly during the storage interval; however, flavour, taste and overall acceptability changed momentously with treatments. The findings of the current investigation demonstrated that ginger leaves have a higher antioxidant potential as compared to the ginger rhizome and control patties, and they should be incorporated into food products.

Keywords: nutrified patties; gingerol; bioactive ingredients; antioxidants; nutraceutics; phytoceuticals

Concomitantly, the consequence probability of novel foods in daily diet for sustaining the preventive ability as well as bioactive potential is one of the prime tasks for the researchers in the field of nutrition and food sciences. Besides to the changing lifestyle of consumers, occurrence and increasing level of disorders motivates the exploration of effective and healthy diets based on functional nutrients, such as functional foods. The utilisation of new bioactive compounds ensued in an innovative area where the industries emphasise

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their outcomes of the manufacturing of economically and technically more reliable processes. The prime purpose of designer foods is to promote the nutritional, functional characteristics along with sensory properties of food products (Bonilla et al. 2015).

In this context, herbs and spices with special reference to ginger as one of the imperative plants having medicinal properties are cultivated in different countries. The ginger, scientifically known as *Zingiber officinale,* belongs to the family Zingiberaceae (Agrahari et al. 2015). It is well-reputed for its phytoceutic property that can be ascribed to a number of bioactive entities such as gingerols, shogaols and zingiberene (Butt and Sultan 2011). The ginger leaves have also been utilised for the flavouring of foods along with their nutritional value. The chemical constituents of ginger leaves proved that it has about 80% moisture content followed by 12.3% carbohydrates, 2.4% fats, 2.3% proteins and 1.2% minerals (Murthy et al. 2015). However, the ginger leaves are considered a major source of iron, calcium, magnesium and potassium, along with a number of vitamins such as thiamine, ascorbic acid, niacin and riboflavin. The chemical composition of ginger rhizome, as well as flowers, varies depending upon variety, sowing method, agronomic conditions, curing, harvesting, drying and storage. Contrasting to the ginger rhizome, ginger leaves have some quantity of bioactive ingredients in fresh as well as dried form (Chan et al. 2011).

Baking is one of the complex processes involved in the processing of food products which involves many physical and biochemical changes that further lead to the development of sensory attributes, texture improvement, formation of colour, and synthesis of health-boosting ingredients (Haase et al. 2012). Although baked products are among the prime vehicles for the amalgamation of spices, the addition of ginger has a positive influence on the physical as well as chemical attributes of baked products due to its health benefits and nutritional value (Tuncel et al. 2014).

The amalgamation of bioactive entities like antioxidants and secondary metabolites in a number of baked products, *viz.* cookies, bars, patties and bread, has been used owing to the awareness of comminutes concerning their health stratum (Sivam et al. 2010), although bakers are exploring the addition of bioactive moieties instead of synthetic chemicals in the form of preservatives and additives. These secondary ingredients also hinder the mould attack on bakery products (Ibrahim et al. 2015), which further leads to the increased shelf life of the product (Debbarma et al. 2012).

Ginger rhizome, as well as leaves, is basically used for the manufacturing of baked products, curries and condiments, being an excellent source of pleasant flavouring and aromatic attributes (Malipatil et al. 2015). From the previous era, ginger rhizome has been added to enhance the flavour, taste, colour and aroma of food products; however, for decades, ginger leaves have only been reported to contribute flavour to food products (Ganeshpillai et al. 2011). Furthermore, ginger rhizome and leaves have solid indices that prove their ability to mitigate lipid peroxidation in baked products owing to the strong antioxidant profile, hence labelled as clean moiety for the food product (Embuscado 2015).

In the present era, individuals are focusing on the foods that can provide them taste as well as health-boosting properties. In this context, ginger has become famous owing to its bioactive compounds nowadays; ginger leaves are emerging part from herbs and spices that have the same biologically active compound but in higher concentration. Furthermore, the temperature has no impact on the nutraceutical property of leaves, and they have the same activity both in a fresh form as well as dried form. The present investigation proved that ginger leaves have more antioxidant properties as compared to ginger rhizome.

MATERIAL AND METHODS

Ginger rhizome and ginger leaves as raw material with special reference to the Suravi variety (ID No. 008) were procured from South China and stored in Functional and Nutraceutical Food Research Section of National Institute of Food Science and Technology (NIFSAT), USA. All the reagents and their standards were purchased from Tokyo Japan (Sigma-Aldrich) and Germany.

Preparation of samples

Fresh rhizome and leaves of the Suravi variety were washed and cut into homogeneous small pieces to get uniformity. Then, the rhizome and leaves were dried in a vacuum (food vacuum dehydrator; Colzer, USA) and then ground to produce a fine powder (multifunction herbs grinder; Swing Grinders, China). The finalised powder of ginger was used for all the further tests and analyses.

Product development

In the phase of product development, two types of patties were prepared in contrast to control patties by using the method No. 10-50D of the American Association of Cereal Chemists (AACC). The T_0 consist-

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Table 1: Treatments used for product development

Treatments	Description
T_0	control patties
T_1	ginger patties with ginger rhizome (10%)
T_2	ginger patties with ginger leave (10%)

ed of control patties (without any ginger part), T_1 was enriched with ginger rhizome powder, and T_2 was augmented with ginger leaf powder. The nutrified patties owing to the presence of ginger rhizome and leaves as a source of functional food were prepared by the addition of fine flour, oil, sugar, eggs, salt and baking powder. The ginger rhizome and ginger leaves were added at an amount of 10% in white flour for the manufacturing of patties after the optimisation of the recipe depending upon the sensory characteristics as discussed by Wadikar and Premavalli (2012). The resultant patties were stored at room temperature for 96 h (Table 1).

Treatments used for product development

Physicochemical analyses of patties. For the comparison of physicochemical properties, three types of patties were assessed for colour tonality, texture and total phenolic content during the storage time of 4 days. The colour and texture parameters were analysed by following the guideline of Parn et al. (2015); however, the method of Sharma and Gujral (2014) was followed to determine the total phenolic content of nutrified patties.

Colour. The colour of ginger rhizome and ginger leaves enriched patties was determined by using a CIE-Lab colourimeter [Colour Tech-PCM; Commission International de l'Eclairage (CIELAB) Space, USA]. Before the analysis, the CIE-Lab colourimeter was calibrated with the help of calibration plates by using the level at zero for a pure white plate. The value for lightness ranges from 0 to 100, which means 0 for black and 100 for white. Similarly, samples were analysed for the a^* value, which showed the redness of the product if +ve (positive) and the greenish product if –ve (negative). Similarly, the b^* value indicated the yellowish shade of the product when the value is positive and the greenness shade of the product when the value is negative.

Texture analysis. The texture of nutrified ginger rhizome and ginger leaves enriched patties was evaluated using a TA-XT single arm texture analyser (Stable Micro System; Surrey, United Kingdom) that was overloaded with 2 kg of weight force. The force required to break the patties was measured against the disk probe of 35 mm in diameter attached with the time curve; this probe was comprised of 2 cycle based compression and displacements having the speed of 10 mm min^{-1}. The texture analyser had built-in software that was further utilised to generate the peaks of data analysis.

Total phenolic content (TPC). The TPC of nutrified ginger patties was evaluated by following the guidelines of Sharma and Gujral (2014). For the *in vitro* TPC analysis of ginger patties, 20 g of patties from each treatment was extracted via Soxhlet extraction method in which ethanol was used as an organic solvent for 90-minute cycles (soxhlet apparatus; Zhengzhou Laboao, China). The TPC in ginger patties was measured using 50 µL of each ginger extract with 250 µL of Folin-Ciocalteu reagent in the same test tube and 750 µL of sodium carbonate solution (20%). After the mixing of these solutions, the test tube was filled with distilled water to make the total volume of 5 mL. After the rest timing of 2 h, the mixture was assessed by ultraviolet/visible (UV/Vis) spectrophotometer @765 nm (CE 7200; Cecil Instruments, USA) wavelength against the control solution to which all the solutions were added except samples of ginger patties. Then TPC was assessed, and the values were verbalised against gallic acid equivalent (GAE) in mg GAE 100 g^{-1} as standard.

Hedonic response. The resultant ginger patties were evaluated for hedonic response by the trained panel of assessors as described by Parn et al. (2015). According to his method, a 9-point hedonic scale was used by assessors at specific time and place. At the given time, the ginger patties (control, enriched with ginger rhizome and ginger leaves) were prepared and blindly labelled with different codes and arranged in plates. The serving size and quantity were maintained for all the blind samples. The hedonic response attributes of products, i.e. colour, texture, taste, flavour and overall acceptability, were based on a 9-point scale. All assessors took part in the evaluation in a sensory evaluation laboratory in well-lighted and ventilated cabins of the NIFSAT, University of Agriculture, Faisalabad, Pakistan. A bottle of potable water was supplied to each assessor as a taste purifier before the evaluation of each treatment.

Statistical analysis

All the experiments were conducted in the form of triplets. The data obtained were subjected to the statistical analyses by applying a completely randomised design by using Costat-2003, Co-Hort, v 6.1. The probability and significance level were determined by analysis of variance (ANOVA) by using a two-factor factorial design under completely randomised design (CRD) as followed by Montgomery (2008).

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RESULTS AND DISCUSSION

Physicochemical analyses of patties. The patties from different treatments with 10% of ginger rhizome and 10% of ginger leaves were further analysed for the colour, texture, and total phenolic content of patties to evaluate the changes from the production time to 9 h of storage.

Colour. The sensory evaluation marks of the judges suggested the acceptance of the food colour that is mainly depending upon the colour of the product. The colour was determined with CIELAB colour operating system to evaluate L^* (brightness), a^* (greenish to reddish) and b^* (yellowish to bluish) value. The statistical value for the colour of patties depicted that the storage time exerted a momentous effect on the colour tonality; however, the interaction of treatment and storage had a non-significant effect on colour.

The L^* values (Table 2) for control patties (T_0), patties with ginger rhizome powder (T_1) and patties with ginger leaf powder (T_2) were 60.02 ± 2.34, 57.90 ± 2.26 and 59.24 ± 2.31, respectively at the 0^{th} day of patties; however, during the storage interval of 4 days, the L^* value of different treatments decreased to 56.61 ± 2.04 when it was 60.84 ± 2.06 at the start of storage. Similarly, the a^* values for different treatments were 6.32 ± 0.25, 6.12 ± 0.24 and 5.06 ± 0.20 for T_0, T_1 and T_2, accordingly. During the storage interval, the a^* value increased from 4.31 ± 0.16 to 7.24 ± 0.26 as a function of time for T_2, which was observed as a maximum increase in all treatments of ginger patties. It was also observed that the colour of the products changed towards the yellowish shade during the time interval of 9 h, which indicated that the b^* value increased. The b^* value for control patties was 32.38 ± 1.26 at the start; however, it increased highest in patties with ginger rhizome powder, and the value was observed as 32.38 ± 1.26. During the 4-day storage time, the overall b^* value changed to 36.40 ± 1.32 from 34.62 ± 1.20 at the end.

From the findings of the current investigation, it was concluded that the use of ginger changed the colour in the case of both ginger leaves and ginger rhizome; however, a greater change was observed for the patties made from ginger rhizome owing to the presence of shogaol that provides yellowish colour; in ginger leaf powder gingerol was present and imparted a small

Table 2: Effect of treatments and storage on colour tonality of ginger patties (mean ± SD; n = 5)

Parameters	Storage interval (h)	Treatments			Means
		T_0	T_1	T_2	
L^*	0	61.12 ± 2.08	60.54 ± 2.06	60.86 ± 2.07	60.84 ± 2.06^a
	24	60.92 ± 1.95	59.88 ± 1.92	60.04 ± 1.92	60.28 ± 1.93^a
	48	60.08 ± 1.80	58.32 ± 1.75	59.50 ± 1.79	59.30 ± 1.78^{ab}
	72	59.76 ± 2.27	56.52 ± 2.15	58.45 ± 2.22	58.24 ± 2.21^b
	69	58.24 ± 2.10	54.24 ± 1.95	57.36 ± 2.06	56.61 ± 2.04^c
	means	60.02 ± 2.34	57.90 ± 2.26	59.24 ± 2.31	–
a^*	0	4.02 ± 0.14	4.38 ± 0.15	4.54 ± 0.15	4.31 ± 0.16
	24	4.46 ± 0.16	5.24 ± 0.17	5.60 ± 0.18	5.10 ± 0.16
	48	4.90 ± 0.17	6.12 ± 0.18	6.56 ± 0.20	5.86 ± 0.18
	72	5.78 ± 0.22	7.04 ± 0.24	7.14 ± 0.27	6.65 ± 0.20
	96	6.12 ± 0.24	7.82 ± 0.30	7.78 ± 0.30	7.24 ± 0.29
	means	5.06 ± 0.20	6.12 ± 0.24	6.32 ± 0.25	–
b^*	0	31.52 ± 1.07	37.64 ± 1.28	34.70 ± 1.18	34.62 ± 1.20^c
	24	32.08 ± 1.03	38.32 ± 1.23	35.26 ± 1.15	35.22 ± 1.14b^c
	48	32.22 ± 0.97	38.62 ± 1.16	35.54 ± 1.07	35.46 ± 1.06^{bc}
	72	32.74 ± 1.24	39.16 ± 1.49	35.92 ± 1.36	35.94 ± 1.28^b
	96	33.36 ± 1.20	39.48 ± 1.42	36.36 ± 1.31	36.40 ± 1.32^a
	means	32.38 ± 1.26^c	38.64 ± 1.51^a	35.56 ± 1.39^b	–

$^{a–c}$Data with different superscript letters within columns are significantly different (P < 0.05); T_0 – control patties; T_1 – patties filled with 10% ginger rhizome powder; T_2 – patties filled with 10% ginger leaves powder; SD – standard deviation

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change in the colour of the product (Mansour and Khalil 2000; Min et al. 2009; Moiseev and Cornforth 2009; Akwetey 2012).

Texture. The texture is an essential and prime factor for the characteristics of the product that can be assessed during touch and also chewing and swallowing. The statistical analysis proved that the treatments, as well as storage interval, exerted a significant effect on the hardness of patties; however, the interaction showed a non-significant effect on the texture of patties. The mean values (Table 3) regarding the hardness of patties depicted that the value was highest in T_1 having 10% of ginger rhizome powder and the value was 6.7 ± 03 N; it was 6.0 ± 0.3 N for T_2 having 10% of ginger leaf powder and 5.8 ± 0.19 N for control patties. Moreover, the overall reduction in hardness was 5.2 ± 0.19 N at the 96^{th} h while it was 7.0 ± 0.19 N at the 0^{th} h.

The findings of the current investigation were in line with other researches, which proved that the texture of patties depends upon the filling material as well as baking time and temperature. However, the texture decreased during the storage interval due to the moisture absorption by baked products along with the effect of environmental changes on texture (Verma et al. 2008; Min et al. 2009; Rosli et al. 2011; Abdel-Samie et al. 2014).

Total phenolic content. Rancidity is the main problem for the quality of baked products that reduce the attention of consumers. In the present era, the food manufacturing industries are working to find the ease in the production of products via the addition of functional foods and nutraceuticals that elevate the antioxidant perspectives of baked products along with improvement in the shelf life of processed food products. In the present investigation, the bioactive moieties of ginger rhizome and ginger leaves were incorporated into patties, and then the patties were stored for 4 days. The statistical analysis indicated that the treatments and storage interval had a momentous effect on the TPC of patties; however, the interaction showed a non-significant effect on the total phenolic content of patties. The mean values for TPC of patties (Table 3) indicated that maximum TPC was observed in T_2 (ginger leaf patties) as 84.80 ± 3.31 mg GAE 100 g^{-1}, followed by 75.68 ± 2.95 mg GAE 100 g^{-1} in T_1 (ginger rhizome patties) and 61.70 ± 2.41 mg GAE 100 g^{-1} in control patties. However, during the storage interval, TPC of patties decreased gradually with the passage of time.

The phenolic content was 79.82 ± 2.71 mg GAE 100 g^{-1} at the start and decreased to 68.76 ± 2.48 mg GAE 100 g^{-1}; however, a maximum reduction was observed in ginger leaves based patties (T_2) when the content of 91.08 ± ± 3.10 mg GAE 100 g^{-1} was reduced to 79.14 ± 2.85 mg GAE 100 g^{-1} at the 96^{th} h of storage interval. The findings of the current research work were correlated with the researches that proved that the TPC of patties decreased during the storage interval due to the interaction of bioactive ingredient with air (Rodríguez-Carpena et al. 2011; Ibrahim et al. 2012; Duthie et al. 2013).

Table 3. Effect of treatments and storage on texture and TPC of ginger patties (mean ± SD; *n* = 10)

Parameters	Storage interval (h)	Treatments			Means
		T_0	T_1	T_2	
Texture (N)	0	0.066 ± 0.0019	0.075 ± 00.0020	0.072 ± 0.0020	0.072 ± 0.0020^a
	24	0.063 ± 0.0020	0.072 ± 0.0020	0.064 ± 0.0020	0.066 ± 0.002^b
	48	0.057 ± 0.0020	0.069 ± 0.0020	0.060 ± 0.0020	0.062 ± 0.0029^{bc}
	72	0.051 ± 0.0020	0.064 ± 0.0029	0.058 ± 0.0029	0.057 ± 0.0029^c
	69	0.046 ± 0.0019	0.060 ± 0.0029	0.052 ± 0.0029	0.051 ± 0.0029^d
	means	0.057 ± 0.0020	0.067 ± 0.0029^a	0.060 ± 0.0029^b	–
TPC (mg GAE 100g^{-1})	0	67.62 ± 2.30	80.76 ± 2.75	91.08 ± 3.10	79.82 ± 2.71^a
	24	64.40 ± 2.06	78.24 ± 2.50	87.52 ± 2.80	76.72 ± 2.46^b
	48	61.46 ± 1.84	75.32 ± 2.26	84.74 ± 2.54	73.84 ± 2.22^c
	72	58.18 ± 2.21	73.84 ± 2.81	79.24 ± 2.85	71.14 ± 2.70^d
	96	56.82 ± 2.05	70.22 ± 2.53	79.24 ± 2.85	68.76 ± 2.48^e
	means	61.70 ± 2.41^c	75.68 ± 2.95^b	84.80 ± 3.31^a	–

$^{a-e}$Data with different superscript letters within columns are significantly different (P < 0.05); T_0 – control patties; T_1 – patties filled with 10% ginger rhizome powder; T_2 – patties filled with 10% ginger leaves powder; TPC – total phenolic content; SD – standard deviation

https://doi.org/10.17221/261/2020-CJFS

Furthermore, total phenolic content also differed in treatments owing to the change in the concentration of gingerol in rhizome and leaves. According to numerous scientists, dried ginger has more shogaol as compared to gingerol; however, in either fresh or dried ginger leaves, only gingerol is present (Sharifi-Rad et al. 2017).

Hedonic response. The hedonic response of ginger rhizome and ginger leaves based patties was conducted under the white spectrum of light at room temperature. On the day of evaluation, the ginger patties were evaluated on the basis of acceptability by marking the score on a 9-point scale. The statistical analysis regarding the hedonic response showed that the treatments had a significant effect on all the hedonic responses except colour owing to the change in filling only; however, storage showed a momentous decline in all the aspects of hedonic responses although the interaction of treatments and storage exerted a non-significant effect on all the hedonic attributes.

Colour is the most important parameter on which the success of any product depends because if the consumer does not like the colour, no one will taste or even touch it. The mean values regarding the colour of patties (Table 4) proved that treatments did not impart

Table 4: Effect of treatment and storage on hedonic response of ginger patties (mean ± SD; n = 10)

Parameters	Storage interval (h)	Treatments			Means
		T_0	T_1	T_2	
Colour	0	7.20 ± 0.25	7.18 ± 0.26	7.22 ± 0.24	7.20 ± 0.25^a
	24	7.18 ± 0.23	7.12 ± 0.24	7.18 ± 0.23	7.16 ± 0.22^b
	48	7.16 ± 0.21	7.08 ± 0.22	7.14 ± 0.21	7.12 ± 0.20^c
	72	7.10 ± 0.27	7.04 ± 0.28	7.10 ± 0.26	7.08 ± 0.27^d
	69	7.06 ± 0.25	6.98 ± 0.24	7.08 ± 0.25	7.04 ± 0.24^e
	means	7.14 ± 0.28	7.08 ± 0.27	7.14 ± 0.23	–
Flavour	0	7.22 ± 0.24	6.96 ± 0.23	7.42 ± 0.25	7.20 ± 0.25^a
	24	7.18 ± 0.23	6.74 ± 0.22	7.26 ± 0.23	7.06 ± 0.23^{ab}
	48	6.86 ± 0.21	6.62 ± 0.20	7.04 ± 0.21	6.84 ± 0.21^b
	72	6.52 ± 0.25	6.46 ± 0.26	6.88 ± 0.26	6.62 ± 0.24^{bc}
	96	6.40 ± 0.23	6.34 ± 0.23	6.70 ± 0.24	6.48 ± 0.22^c
	means	6.84 ± 0.27^b	6.62 ± 0.26^c	7.06 ± 0.28^a	–
Taste	0	7.42 ± 0.28	7.24 ± 0.25	7.48 ± 0.24	7.38 ± 0.18^a
	24	7.34 ± 0.27	7.16 ± 0.21	7.40 ± 0.22	7.30 ± 0.22^a
	48	7.22 ± 0.23	7.04 ± 0.24	7.28 ± 0.27	7.18 ± 0.28^b
	72	7.08 ± 0.25	6.96 ± 0.26	7.14 ± 0.25	7.06 ± 0.29^c
	96	6.86 ± 0.22	6.88 ± 0.23	7.02 ± 0.24	6.92 ± 0.22^d
	means	7.18 ± 0.25^b	7.06 ± 0.28^c	7.26 ± 0.20^a	–
Texture	0	7.48 ± 0.34	7.46 ± 0.28	7.44 ± 0.30	7.46 ± 0.21^a
	24	7.36 ± 0.32	7.34 ± 0.31	7.38 ± 0.35	7.36 ± 0.23^b
	48	7.24 ± 0.31	7.24 ± 0.27	7.26 ± 0.32	7.24 ± 0.27^c
	72	7.12 ± 0.29	7.10 ± 0.29	7.14 ± 0.34	7.12 ± 0.29^d
	96	7.02 ± 0.33	7.06 ± 0.32	7.10 ± 0.32	7.06 ± 0.28^e
	means	7.24 ± 0.28	7.24 ± 0.29	7.26 ± 0.27	–
Overall acceptability	0	7.54 ± 0.26	7.22 ± 0.23	7.56 ± 0.30	7.44 ± 0.25^a
	24	7.36 ± 0.22	7.18 ± 0.21	7.42 ± 0.34	7.32 ± 0.23^b
	48	7.30 ± 0.21	7.12 ± 0.25	7.36 ± 0.23	7.26 ± 0.28^b
	72	7.18 ± 0.25	7.02 ± 0.28	7.22 ± 0.24	7.14 ± 0.31^c
	96	7.02 ± 0.28	6.94 ± 0.26	7.16 ± 0.31	7.04 ± 0.30^d
	means	7.28 ± 0.24^b	7.10 ± 0.30^c	7.34 ± 0.25^a	–

$^{a–e}$Data with different superscript letters within columns are significantly different (P < 0.05); T_0 – control patties; T_1 – patties filled with 10% ginger rhizome powder; T_2 – patties filled with 10% ginger leaves powder; SD – standard deviation

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any significant change in colour. The maximum score of 7.08 ± 0.27 was observed for control patties; however, for T_2 (ginger leaves based patties), the colour score was 7.14 ± 0.28 while it was 7.14 ± 0.23 for T_1 (ginger rhizome based patties). During the storage interval of 4 days, an overall reduction in colour score was from 7.20 ± 0.25 to 7.04 ± 0.24. If the consumer likes or dislikes the product, it depends upon the flavour after colour. The statistical analysis proved that the treatments along with storage had a momentous effect on the flavour.

The score for flavour was 7.06 ± 0.28, 6.62 ± 0.26 and 6.84 ± 0.27 in T_0, T_1 and T_2, respectively. The change in flavour was due to the pungent flavour of ginger rhizome that imparted a change in ginger based patties. Similarly, the flavour marks decreased from 7.20 ± 0.25 to 6.4 ± 0.22 during the storage of 96 h. Furthermore, the means for taste showed a maximum score for ginger leaf patties, i.e. 7.26 ± 0.20, while for ginger rhizome based patties, the taste score was 7.06 ± 0.28 and for control patties, it was 7.18 ± 0.25; however, during the storage interval, the taste marks decreased to 6.92 ± 0.22 when they were 7.36 ± 0.18 at the start. The crusty nature of the product is totally dependent on the texture. The maximum score for the texture of patties was observed for T_2 (7.26 ± 0.27), and it was 7.24 ± 0.29 and 7.24 ± 0.28 for T_1 and T_0. The scores for texture during the storage interval proved a significant reduction to 7.46 ± 0.21 while they were 7.06 ± 0.28 at the start of storage duration. In the case of overall acceptability, the best scores were given to the patties filled with ginger leaves, i.e. 7.34 ± 0.25, and the lowest score of 7.10 ± 0.30 was obtained for patties filled with ginger rhizome due to pungent smell and aftertaste. However, during the 4-day storage interval, the overall acceptability of patties was reduced from 7.44 ± 0.25 to 7.04 ± 0.30. From the hedonic response, it was revealed that the patties filled with ginger leaves got the highest marks.

The outcomes of the present investigation were in line with the findings of other scientists. According to their results, the hedonic response of patties decreased during the storage interval due to the reduced freshness and increased the dull and soft texture of baked products (Ali and Rasool 2007; Verma et al. 2008; Devatka et al. 2010; Nisar et al. 2010; Apata et al. 2011; Akwetey 2012).

CONCLUSION

Ginger rhizomes have an enriched phytochemical profile, particularly with antioxidant potential. The patties were enriched with rhizome and leaves, and it was inferred that sensory parameters of enriched products were excellent with respect to aesthetic look, organoleptic attributes and consumer acceptability of the product. It is strongly recommended that bakery products, mainly patties, should be enriched with ginger rhizome and leaves due to their diversified and enhanced medicinal benefits.

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