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RESEARCH ARTICLE

Quality attributes of Cookies Prepared with Moringa (*Moringa oleifera*) Seed Oil

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ABSTRACT

Moringa oleifera is center of attraction worldwide and considered the most important economical tree crop. Generally individuals utilize moringa leaves and flowers as vegetable in cooking while other parts are being used as animal feed. Moringa seeds are enriched with 35-40% edible oil having higher amount of monounsaturated fatty acid. Saturated fatty acids are found in less quantity while reduced amounts of behenic acids, arachidic and palmitic acids and just traces of polyunsaturated fatty acids are found in moringa oil. There is excessive demand for new nutrients enriched and cost effective edible oil sources to be discovered rather than conventional oils. The current research was to find suitability of moringa oil in cookies preparation by using moringa oil in various percentages from 0 to 100 % in making cookies. GC-MS analysis performed for the moringa oil indicated that fatty acid profile of moringa oil by solvent and mechanical extraction contain 77.64±0.2 and 75.63±1.17% omega 6 fatty acid while and total unsaturated fatty acid of solvent extracted oil was 81.18±0.09% that is excellent as compared to the mechanical exacted oil that contains 77.41±0.08%. The statistical results showed that breaking strength of moringa oil cookies was non-significant for both solvent extracted and mechanical extracted oil. Fat content of T_2 (15.657±0.008) was high than the others while overall acceptability, crispiness and flavor of T_1 was good as compared to others. T_0 were acceptable overall without creating adverse effect on sensory qualities. The product thus formed contains sufficient amount of valuable compounds that are helpful in maintaining the healthy lifestyle.

INTRODUCTION

Moringa oleifera one of important vegetable crops belonging to family moringaceae and order brassica. Moringa is recognized by its drumstick shaped long pods containing different number of seeds. It is called as “miracle tree” because of its healing property for injury and also gives protection from some chronic diseases. Moringa oil is high resistance to oxidation to other oil such as olive oil due to presence of various compositions (Faisal et al., 2019). In the Indian language *M. oleifera* is also named as Murungai a Tamil word, meaning of this word which is “twisted pod”. Other traditionally regional names are Saijhan and Sohanjana (Dhakad et al., 2019). Moringa is generally recognized as drumstick plant or horseradish tree or Ben oil tree in English literature, favorably grown in many regions of world especially Indian climatic conditions. It is unique and significant food product that has gained attraction as the ‘tropical’s natural nutrition (Arnarson, 2020). Mature moringa plant bear fruits or pods in different numbers having almost 20 seeds in one pod which can grow up to 60m cm with light green to dark green initially and dry to brown in color when become mature. Moringa pods differ in numbers ranging from 10 to 62 with 25.5 to 37.7g in weight having an average of 100 seeds with appreciable amount of oil contents (Hassanien et al., 2018). Moringa oil has pleasant taste and almost same properties like olive oil. It has high degree of unsaturation due to high proportion of oleic acid olive oil (Yusoff et al., 2019). Numerous techniques have been reported for oil extraction, whereas solvent extraction is a common method used in lab scale for maximum yield. In a classical approach, n-hexane or petroleum ether is used as solvent for oil recovery from moringa seeds which is in line with methods used for other oil seed crops. The oil yield can be increased by combination of techniques like microwave assisted extraction or use of ultrasounds during process. The maximum yield, up to 95% has been observed in microwave assisted oil extraction techniques (Zhong et al., 2018). The method used for oil extraction does not influence the properties including refractive index and density of oil whereas the smoke point is greater than olive oils (Tsaknis et al., 1999). Chemically, moringa seed oil is a blend of saturated and unsaturated fatty acids with high proportion of monounsaturated fatty acids. Palmitic acid (21.18%) is a chief saturated fatty acid whereas oleic acid (76.73%) is a predominant form of unsaturated fatty acid. A small fraction of polyunsaturated fatty acids including linoleic and linolenic acids along with traces of erucic acid are also found in moringa oil (Ogunsina et al., 2014). Moringa plant used extensively for medicinal purpose due to its unique nutritional and biochemical profile including good quality edible oil (Djemoui et al., 2019). Moringa oil was also used by ancient Romans and Greeks to protect skin infections (Soumya et al., 2019). Moringa seed oil possessed numerous health benefits due to its unique composition of fatty acids and used in traditional medicines to cure many diseases including hypertension and arthritis (Chen et al., 2019). It has wide range of health implications to treat more than three hundred diseases due to high proportion of phytochemicals like flavonoids (Reetu et al., 2020). Moringa oil is believed to have superior stability as compared to olive oil due variable proportion of fatty acids (Ayerza et al., 2019; Mahfuz et al., 2019). Moringa oil can be used in frying process due to high oxidative stability. This property of oil increase the shelf life of food products prepared with moringa seed oil including cookies and other products (Saucedo-Pompaa et al., 2018). Due to its unique composition, moringa oil is highly suitable for margarine production as compared to other local hydrogenated fats and oils. The stability and shelf life of margarine can be increased by using moringa oil in combination with other vegetable fat and can be used to modify properties of edible oils (Nadeem and Imran, 2016). Keeping in view the significance of moringa seed oil in food products development, current study was designed to expedite its role in cookies production as a replacer of commercially available vegetable fat used as shortening.

MATERIALS AND METHODS

Raw material handling

The moringa (*Moringa oleifera*) seed were obtained from locally oil and ghee processing industry of Multan. The seed were dried and dehulled before oil extraction and further processing.

Oil extraction

Moringa seeds were grounded using blending machine to form moringa seed powder. 35g seed powder placed in thimble and fitted in Soxhlet extractor. The n-hexane used as solvent heated at 50-60℃ continuously for 2-3hrs maximum oil recovery. Whereas, during mechanical extraction whole seeds (100g) poured into the hopper of a locally designed cold presser. The machine was assisted with slight heating to rupture oil follicles to enhance oil extraction (Yusoff et al., 2017). The oil yield was assessed using the formula:

$$\text{Moringa seed oil yeild (\%)} = \frac{\text{Weight of oil (g)}}{\text{Weight of moringa seed (g)}} \times 100$$

Fatty acid profile of moringa seed oil

Moringa seed oil fatty acid profile was determined through the Gas Chromatography (GC-2010, Shimadzu corporation 07947) as procedure adopted by (Ezeh et al., 2016) with some modifications and FAMEs were prepared before injection. The system equipped with FID detector, split injector and SP-2560 silica fused capillary column (100m x 0.25mm x 0.2µm, Supelco) with operating program: injection volume 1 µL with temperature 250°C, detector temperature 260°C, column temperature 140°C for 5 minutes and then ramped to 240°C with 4°C per minute, remained stable for 15 minutes; helium was used as carrier gas with flow rate of 1.12mL/min and linear velocity of 20 cm/s; split ratio 1:100 (Ezeh et al., 2016).

Moringa seed oil cookies preparation

Moringa seed oil cookies (Table. 1) were prepared using the method 10.50D as explained in AACC with some modifications. The basic ingredients used were as follow flour, sugar, shortening, moringa seed oil, baking powder g, eggs and water. Dough preparation was made in mechanical mixer by mixing ingredients for 15 minutes. The sheeting was done and different shapes of cookies were made through specially designed cutters and baking was done at 175-180°C for 20-30 min (Shabbir et al., 2017).

Physicochemical analysis of cookies

The overall thickness and diameter of moringa seed oil cookies was determined according to description as mentioned by (Kaur et al., 2013). For estimation of diameter, six cookies were arranged edge to edge and total diameter noted in centimetres by using a scale. The same was performed by rotating cookies to 90° and values were measured and values were expressed ad mean of triplicates. Likewise, for determination of thickness, six cookies were arranged on each other and total height was determined using calibrated vernier caliper and mean values were noted. The spread actor of cookies was measured by taking ratio of cookies diameter and thickness (Seevaratnam, 2012).

Compositional analysis of moringa seed oil cookies

Compositional (proximate composition) analyses of cookies like moisture contents (method: 44-15A), ash contents (method: 08-01), crude fat contents (method: 30-10), crude fiber contents (method: 32-10) and crude protein contents (method: 46-10) was determined according to their standard protocols as mentioned in AACC with some modifications as per procedure explained by (Shabbir et al., 2017; Akbar and Ayub, 2018).

Textural studies of cookies

The textural properties of cookies were measured using texture analyzer (Universal testing machine) for properties like breaking strength, cutting strength and hardness according to their respective procedure explained by (Kozłowicz, 2010) by using blade-cutting probe. Pre-test speed and post-test speeds were adjusted as 1.5, and 10 mm/s respectively.

Sensory evaluation

The sensory profiling of prepared cookies was evaluated using 9-point hedonic scale. A panel of judges comprised of male and female from Department of Food Science and technology, MNS-UAM were asked to evaluate cookies for sensory attributes using 9 to l score in which nine was the highest test score whereas one was the lowest score. The cookies were evaluated for color, flavor, texture, taste and overall acceptability. All the panelists were 25-45 years old with good health and sensory characteristics and evaluation was done in a conducive environment to reduce the level of error (Lawless and Heymann, 2010).

Statistical analysis

The data were recorded in triplicate and expressed as means ± standard deviation. The significant difference among treatments was measured using simple ANOVA technique under CRD as illustrated by (Montgomery, 2008) using statistical software (Statistix 8.1).

Table 1: Treatment plan for preparation of moringa seed oil cookies

Treatments	Shortening (%)	MO % (S.E)	MO% (M.E)
T_0	100	_	_
T_1	50	50	_
T_2	_	100	_
T_3	50	_	50
T_4	_	_	100

RESULTS AND DISCUSSION

The moringa seed oil was evaluated for fatty acid profile and subjected for its application in cookies production by replacing it with the conventional shortening. The results obtained described and discussed here are as follows:

Fatty acid profile

Fatty acid profile of moringa (*Moringa oleifera*) seed oil was evaluated through Gas Chromatography (GC) for both solvent (S.E) extraction and mechanical extraction (M.E) samples. Overall it was noticed that unsaturated fatty acids found in higher proportion as compared to saturated fraction and mean observed as 81.18±0.09 and 77.41±0.08% respectively (Table 2). GC analysis indicated the presence of oleic acid in both oil samples and examined as 74.46±0.3 and 74.07±0.31% for solvent and mechanical extraction. the spectra of other fatty acids like linolenic acid, linoleic acid, arachidic acid, stearic acid, palmitoleic and palmitic acid were observed as 0.32±0.00, 1.71±0.08, 2.80±0.01, 4.68±0.06, and 1.04±0.02 and 6.51±0.02% respectively during solvent extraction. whereas, in mechanical extracted oil the fatty acids contents were observed in amount as 0.12±0.00, 0.62±0.00, 3.75±0.00, 6.28±0.02, 1.17±0.01 and 6.67±0.05% respectively. The presence of omega 6 fatty acids was noticed in both samples as 77.64±0.2 (S.E) and 75.63±1.17% (M.E). Edible oil with high content of oleic acid recommended for food applications due to its wide range health implications. The results of present study are in harmony with earlier findings of Faisal et al., 2019 who also observed the same results regarding fatty acid contents of moringa oil. The little variation may attributed due to climatic factors and geographical distribution. The overall picture of results for the said parameter also statistically comparable with previous investigations Anwar et al., 2006 and Ayerza, 2011 who observed that fatty acid percentage of oil was influenced by genotypes used during the study. Tamilselvi et al., 2018 also suggested that saturated contents of fatty acids found lower that the unsaturated contents which determines the key elements in moringa seed oil quality. They further confirmed that difference in values also existed due to varietal change like saturated fatty acids found in *M. oleifera* (18.3%) seed oil is lower than *M. concanensis* which may indicate the influence of their gene pool (25.15%).

Proximate analysis of moringa seed oil cookies

The statistical values regarding composition of cookies showed significant variation in different parameters during storage like ash and moisture contents ($p <0.05$). The mean values for moisture contents of treatments on cookies quality were examined as T_0 (6.948±0.02), T_1 (6.990±0.008), T_2 (7.116±0.05), T_3 (7.146±0.004) and T_4 7.232±0.07%. The findings of the present study are

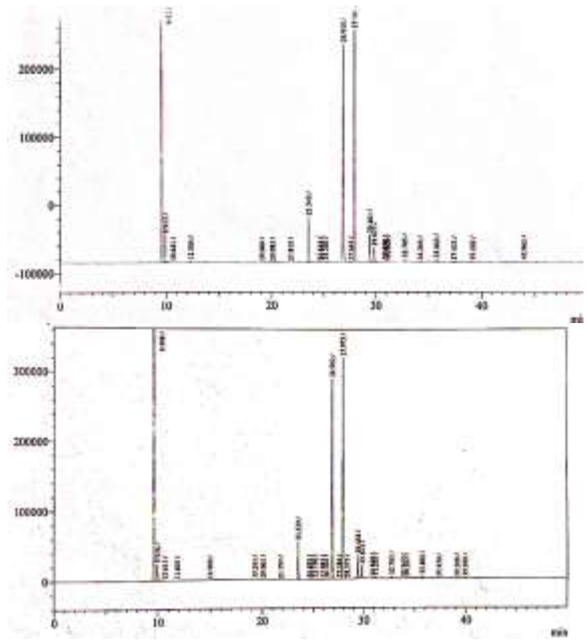


Fig. 1: General chromatograms conferring to retention data from examined standard samples intensity through GC analysis in which Helium gas was being used as carrier of sample although temperature programing was fixed between 70°C-280°C range.

Table 2: Fatty acid profile of moringa seed oil (g/100g oil)

Fatty Acids	Moringa oil (S.E)	Moringa oil (M.E.)
Palmitic Acid	6.51±0.02	6.67±0.05
Palmitoleic Acid	1.04±0.02	1.17±0.01
Stearic Acid	4.68±0.06	6.28±0.02
Oleic Acid	74.46±0.3	74.07±0.31
Linoleic Acid	1.71±0.08	0.62±0.00
Arachidic Acid	2.80±0.01	3.75±0.00
Eicosatrienoic Acid	1.91±0.00	1.63±0.00
a-Linolenic Acid	0.32±0.00	0.12±0.00
Total saturated fatty acid	18.71±0.01	22.45±0.04
Total unsaturated fatty acid	81.18±0.09	77.41±0.08
Total monounsaturated fatty acid	78.56±0.41	76.60±0.04
Total polyunsaturated fatty acid	2.26±0.08	0.84±0.01
Total omega 3 fatty acid	0.6±0.05	0.22±0.00
Total omega 6 fatty acid	77.64±0.2	75.63±1.17

Values expressed as mean ± standard deviation (n=3). S.E: Solvent extraction; M.E: Mechanical extraction.

in accordance with the outcomes of Waheed et al., 2010 and Obi et al., 2018 who confirmed that variation in moisture may attributed by environmental conditions. The overall mean values regarding ash contents of cookies for different treatments were recorded as T_0 (0.695±0.02), T_1 (0.684±0.008), T_2 (0.688±0.05), T_3 (0.693±0.02) and T_4 (0.682±0.06%). It was observed that maximum value was found in T_0 whilst minimum value was noted in T_4. The results found during the study are comparable with earlier findings of Waheed et al., (2010) and Dillasamola et al., (2018) who found the similar variation in ash contents during storage studies of cookies. Similarly, during present study nonsignificant interaction of treatments and crude protein was noticed. The maximum values for crude protein contents was measured in T_0 and minimum values was observed in T_3 whilst overall means among different treatments were recorded as 6.866±0.02, 6.843±0.05, 6.850±0.004, 6.821±0.08 and 6.836±0.01% for T_0, T_1, T_2, T_3 and T_4 respectively. The present findings corelated with earlier findings of Chester et al. (2019), who also noticed same results and inferred it due to breakdown of protein during storage. A significant variation in fat contents was observed ($p < 0.05$) as a part of treatment used during study. The overall mean values of fat contents was determined as 15.422±0.09, 15.440±0.01, (15.437±0.006), (15.407±0.05) and 15.387±0.008% for treatments T_0, T_1, T_2, T_3, T_4 respectively.

Similarly a nonsignificant interaction was noticed regarding crude fibre contents of moringa oil cookies. The mean values recorded for different treatments were found as 1.660±0.02, 1.657±0.006, 1.652±0.04, 1.638±0.001 and 1.647±0.07% for T_0, T_1, T_2, T_3, T_4 respectively. The findings of the current work can correlate with earlier investigations of Dillasamola et al. (2018) who inferred a negative correlation between crude fiber contents and storage time.

Physical characteristics of moringa oil cookies

A nonsignificant interaction regarding cookies weight and diameter and treatments was noticed ($P<0.05$), whereas significant variations was monitored in thickness in all treatments used in present studies (Table 4). The maximum value of diameter was observed in T_0 (5.460±1.37), whilst minimum value at T_1 (5.356±1.34).

Similarly, significant interaction regarding spread ratio and treatments was observed in moringa oil cookies showing maximum value as 8.200±2.17 (T_2), whereas minimum values were recorded as 7.396±1.93 (T_4). Likewise highest value of thickness was noticed in T_1 (0.706±0.008) and lowest values in T_0 (0.673±0.008). in a same manner weight was found higher in T_1 (8.840±2.35) and lower weight was observed in T_3 (8.803±2.34). The outcomes of present study for the said parameters are in line with previous findings of Hazra et al. 2019 and Gopalakrishnan et al. 2020. Numerous investigations showed that higher spread factor of cookies considered most desirable for quality of cookies (Biswas et al., 2020). The overall findings of present study regarding thickness of moringa oil cookies found in accordance with the results of El-Haddad et al., 2019 with little variation which could be urged due to variation in chemical composition of oil used in cookies preparation.

Table 3: Proximate analysis of cookies prepared with moringa oil

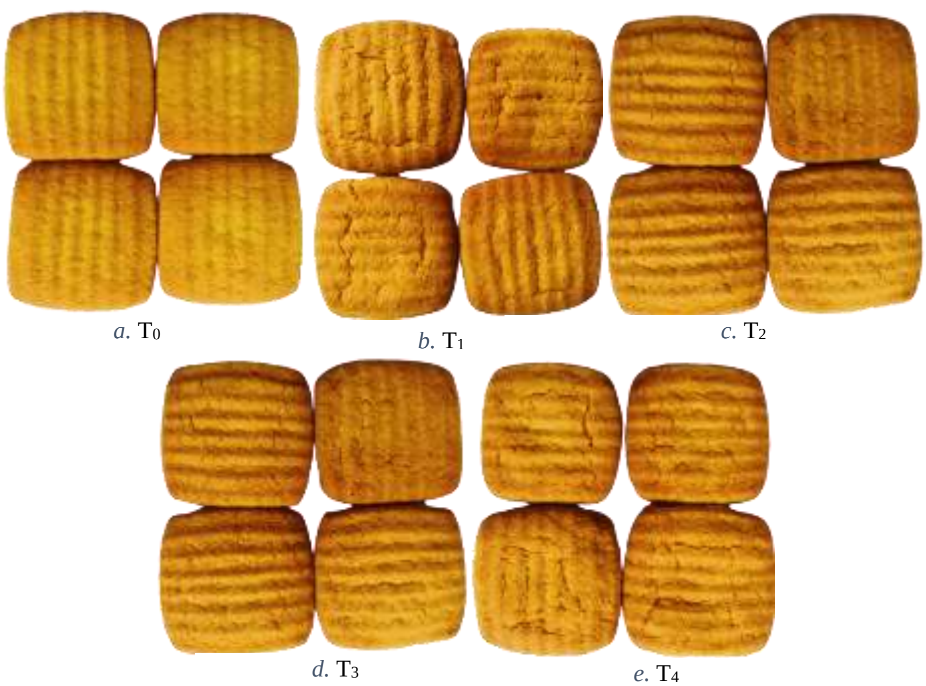
Parameter (%)	Days	Treatment				
		T_0	T_1	T_2	T_3	T_4
Moisture	0 day	6.22±0.08^{n}	6.36±0.03^{m}	6.51±0.06^{l}	6.56±0.03^{j}	6.65±0.01^{k}
	15 days	7.27±0.01^{g}	7.18±0.05^{i}	7.28±0.01^{f}	7.27±0.01^{h}	7.34±0.02^{e}
	30 days	7.34±0.24^{e}	7.42±0.01^{d}	7.55±0.01^{c}	7.60±0.02^{b}	7.70±0.01^{a}
Ash	0 day	0.77±0.05^{a}	0.75±0.05^{d}	0.76±0.01^{b}	0.76±0.01^{c}	0.74±0.08e
	15 days	0.68±0.01^{h}	0.67±0.05^{j}	0.68±0.08^{g}	0.69±0.06^{f}	0.67±0.05^{i}
	30 days	0.63±0.03^{k}	0.63±0.06^{l}	0.61±0.03^{o}	0.62±0.06^{n}	0.63±0.05^{m}
Crude Protein	0 day	7.44±0.01^{a}	7.44±0.01^{a}	7.44±0.03^{a}	7.44±0.02^{b}	7.44±0.01^{b}
	15 days	6.85±0.01^{c}	6.85±0.01^{f}	6.84±0.02^{f}	6.82±0.01^{g}	6.85±0.01^{e}
	30 days	6.29±0.01^{h}	6.23±0.02^{i}	6.26±0.03i	6.23±0.02^{j}	6.22±0.02^{l}
Crude Fat	0 day	15.41±0.03^{g}	15.53±0.01^{a}	15.65±0.08^{a}	15.60±0.03^{b}	15.56±0.08^{c}
	15 days	15.49±0.01^{e}	15.43±0.01^{h}	15.38±0.01^{h}	15.35±0.01^{i}	15.34±0.01^{k}
	30 days	15.35±0.06^{i}	15.35±0.01^{i}	15.26±0.03^{l}	15.26±0.08^{m}	15.25±0.01^{n}
Crude Fiber	0 day	1.76±0.05^{a}	1.75±0.01^{c}	1.75±0.08^{c}	1.74±0.05^{d}	1.75±0.01^{b}
	15 days	1.68±0.01^{e}	1.66±0.06^{f}	1.65±0.01^{g}	1.62±0.08^{i}	1.64±0.01^{h}
	30 days	1.53±0.01^{i}	1.55±0.08^{j}	1.55±0.01^{k}	1.52±0.01^{n}	1.54±0.08^{l}
NFE	0 day	69.15±0.01^{g}	68.90±0.01^{h}	68.63±0.05^{j}	68.69±0.05^{i}	68.59±0.05^{k}
	15 days	68.62±0.08^{e}	68.62±0.08^{l}	68.57±0.08^{o}	68.60±0.08^{n}	68.46±0.08^{p}
	30 days	69.53±0.05^{m}	69.67±0.05^{b}	69.63±0.05^{d}	69.71±0.05^{a}	69.63±0.05e

Values expressed mean ± standard deviation (n=3). T_0:100% traditional fat as shortening, T_1 :50:50 traditional fat as shortening and solvent extracted moringa oil; T_2: (0: 100, traditional fat as shortening and solvent extracted moringa oil; T_3:50:50; traditional fat as shortening and mechanical extracted moringa oil; T_4: 0:100; traditional fat as shortening and mechanical extracted moringa oil. NFE: Nitrogen Free Extract.

Table 4: Physical characteristics of moringa oil cookies

Treatment	T_0	T_1	T_2	T_3	T_4
Diameter (cm)	5.46±1.37^{a}	5.35±1.34^{e}	5.38±1.35^{b}	5.36±1.35^{d}	5.38±1.35^{c}
Spread Factor	7.45±1.95^{b}	7.43±1.94^{c}	8.20±2.17^{a}	7.43±1.94^{c}	7.39±1.93^{d}
Thickness (cm)	0.67±08^{e}	0.69±0.09^{b}	0.70±0.08^{a}	0.68±0.01^{d}	0.68±0.09^{c}
Weight (g)	8.84±2.35^{a}	8.84±2.35a	8.76±2.33^{c}	8.80±2.34^{b}	8.68±2.30^{d}

Values expressed as mean ± standard deviation (n=3).



a. T_0 *b.* T_1 *c.* T_2 *d.* T_3 *e.* T_4

Fig. 3: Images of cookies prepared by baking at 180 to 220°C; images captured by canon 1300 D (18 -55mm optical zoom lens). T_0:100% traditional fat as shortening, T_1 :50:50 traditional fat as shortening and solvent extracted moringa oil; T_2: (0: 100, traditional fat as shortening and solvent extracted moringa oil; T_3:50:50; traditional fat as shortening and mechanical extracted moringa oil; T_4: 0:100; traditional fat as shortening and mechanical extracted moringa oil.

Table 4: Textural properties of moringa oil cookies

Treatment	T_0	T_1	T_2	T_3	T_4
Breaking strength (N)	29.73 ± 0.01^{a}	29.64 ± 0.02^{e}	29.68 ± 0.01^{b}	29.67±0.02c	29.64 ± 0.02^{d}
Cutting strength (N)	30.32 ± 0.02^{b}	30.29 ± 0.05^{d}	30.26 ± 0.02^{e}	30.31±0.03c	30.33 ± 0.04^{a}
Hardness (N)	3.85±0.02a	3.76 ± 0.02^{d}	3.77±0.02c	3.78±0.02b	3.74 ± 0.01^{e}

Values are expressed as mean ± standard deviation (n=3).

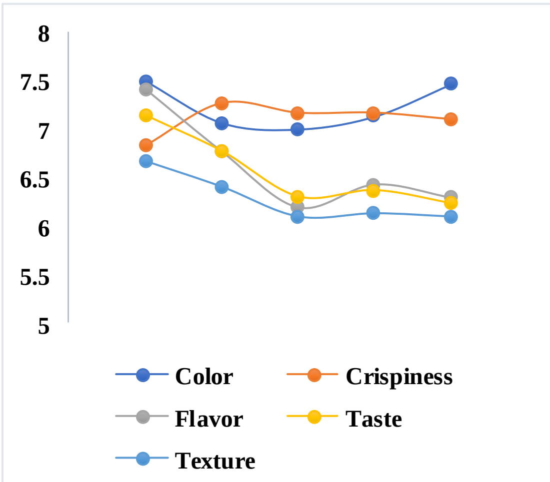


Fig. 5: Sensory profiling of moringa seed oil cookies using 9-point hedonic scale.

Textural properties of moringa oil cookies

Texture is a very important characteristic which makes a significant contribution in overall acceptance of food commodity.

The mean squares regarding breaking strength and cutting strength found nonsignificant ($P<0.05$). the maximum value for breaking strength and cutting strength was observed in T_0 (29.730±0.01) and T_4 (30.333±0.04) whilst minimum values were recorded in T_1 (29.643±0.02) and T_0 (30.323±0.02) respectively. Hardness is a peak force required to break the cookies and desirable for quality attribute for cookies and is the perception of hardness. A number of factors including baking conditions, protein content of flour, nature and chemistry of oil affect the hardness of cookies. The maximum values for hardness was observed in T_0 (3.853±0.02) and minimum values in T_4 (3.743±0.01). Hardness is one of the main indices in the assessment of cookies quality and other acceptable parameters (Djemoui et al., 2018). The interaction of flour and oil used in cookies development influence the hardness of product. Previously, it is documented that sugar may recrystallize during cooling and storage of cookies as loss of water made during baking thus create supersaturated state. The modification in sugar contents through form a glassy solid network after baking would influence hardness of cookies. The values obtained during the present study correlate with earlier findings of Oladeji et al., 2020, who also confirmed the same results. It is inferred that greater breaking strength indicates greater hardness of cookies which may be due to multiple factors during baking and storage (Reetu et al., 2020).

Sensory evaluation of moringa oil cookies

The sensory profiling is an important criteria in field of food product development and ultimate consumer acceptance. The overall values for sensory profiling found non significant for taste, flavor and color whereas significant variation was noticed for crispness and consumer acceptability in all treatments. The mean values for color was observed as 7.500±0.05 (T_0) and 7.000±0.14 (T_2). The results for crispness vary from (6.833±0.23) (T_0) to 7.266±0.20 (T_1). Similarly, the overall values for flavor, taste and texture were recorded as 7.400±0.05, 7.133±0.08, 6.66±0.08 for T_0 and 6.200±0.05, 6.233±0.03, 6.100±0.05 for T_2 and T_4 respectively.

The effect of treatments showed significant variation in overall acceptability of cookies prepared with moringa oil in which maximum values were observed in T_0 (7.433±0.03) whereas minimum values were noticed in T_4 (6.166±0.08). The sensory evaluation of the cookies shown that there were significant differences between the treatments as the concentration of moringa oil varied in cookies. The combined baking properties of affected by moringa oil and organoleptic characteristics of cookies change in oil percentage in treatments. The results found in current studies were in line with earlier findings of Popoola et al., 2020. Numerous investigations conducted by Preeti and Gaurava, 2018, Gupta et al., 2018 and Dhakad et al., 2019 observed similar results those showed similar variation imparted by treatments.

Conclusion

Moringa oleifera acquired significant position in terms of its quality attributes, health benefits and cost effective production technology. This miracle plant possessed appropriate proportion of edible oil having potential benefits for human health. Solvent extraction showed better results in oil yield whereas mechanical extraction also found as good strategy for oil extraction. further trials should be planned to optimize extraction facility for maximum output and evaluate moringa oil for quality and nutritional assessment for its commercial applications.

Authors' contribution

MS proposed the idea and designed the whole research project; ZUZS performed the experiments and allow to publish; UF have supervised the whole journey; SM and MSJ have assisted the project design; NR, AL, GK, ZA, MZS has contributed in write up, lab work and statistical work. All authors read carefully and approved the final manuscript

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