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Usage of *Moringa* Leaves as a Component in some Foodstuff

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ABSTRACT

The target of this investigation was to determine the chemical analysis besides the characteristic of the application of Egyptian *Moringa oleifera* leaves. Results found that the proximate analysis of moringa leaves are rich in protein, carbohydrate and fiber (23.14, 53.63 and10.61%, respectively). *Moringa* leaves are a good source of essential amino acids such as leucine, lysine and valine as follows (22.19, 15.18 and 13.79%, respectively).Moreover, major fatty acids in *Moringa* leaves were oleic acid ($C_{18:1}$) (40.24%), linolenic acid ($C_{18:2}$) (19.43%), palmitic acid($C_{16:0}$) (15.63%) as well as linoleic acid ($C_{18:2}$) (7.95 %) .Furthermore, essential minerals especially Ca and K. Results also showed that having an abundance of bioactive components and natural antioxidants (phenolic content (33.12 mg GAE/g extract), flavonoids content (18.12 mg/g), ascorbic acid content (17.67 mg/100g) and antioxidant activity (78.98%). Generally, the sensory quality of application fortified with leaves powder for potential with the item in food confirmed that the ability to use it as additives or food fortification. The best of the sensory assessments showed that, the *Mentha* /*Moringa* in tea bags was (97% *Mentha* + 3% *Moringa*), prepared salad using *Moringa* as a spice and fortification was (99.4% salad + 0.6% *Moringa*) and the crackers (snack) products was (95% wheat flour + 5% *Moringa*). As a result, it is suggested that recommendation to improve the consumption from it to treat malnutrition in developing countries.

Keywords: *Moringa oleifera* Lam., chemical composition, essential amino besides fatty acids profile, antioxidant activity, polyphenolic compounds, ingredient, application.

INTRODUCTION

Moringa oleifera (MO) has been a perfect source of protein and antioxidants, unsaturated fatty acids furthermore vitamins. The nutritional, besides the medicinal characteristic of MO products, have recently appeal attention from various industries world (Ayoola *et al.*, 2019).

On a world scale, there has been high extending in the herbal medicine and these ones drugs are fast popularity in developed and developing countries owing to their natural origin and minimal side effects (Abijo *et al.*, 2019).

The international nutritional supplement market has seen quick growth with the trend expected to continue (Omotoso, 2018 and Ari-egoro *et al.*, 2019). Leaves can be eaten fresh, cooked and kept its powder in the absence of cooling and without nutritional properties being reduced. Due to the existence of a number of important phytochemicals in its leaves and rich in nutrients (Ponnuswami and Rani, 2019).

Some studies have shown that *moringa* leaves are protein-rich, varying from 179 to268 g/kg of dry matter (DM) and have an amino and fatty acid profile, vitamin and minerals that is adequate for human (Zhang *et al.*, 2019). Extracts from the leaves are applied to manage malnutrition, it is applied as a possibility antioxidant or anti-inflammatory addition anticancer also, antidiabetic and antimicrobial agent (Yunusa *et al.*, 2019).

Apart from acting as a perfect source of natural antioxidants, *Moringa* leaves were abundant sources of protein, potassium and calcium. Improve the storage time of fat-containing foods with regard to the existence of a different class of antioxidant compounds, including flavonoids or phenolic and carotenoids (Daulay *et al.*, 2019).

The target of this research was to determine gross chemical furthermore, polyphenol content addition amino as well as fatty acid profiles. Also, antioxidant and mineral. Moreover, the work targeted to examine the probability of utilizing *Moringa* leaves in preparing and ingredients of some foodstuff products.

MATERIALS AND METHODS

Materials:-

***Moringa* leaves:-**

The special farm in Wadi El Natroun, Beheira - Governorate, Egypt collected fresh leaves. All materials that were wilted and clearly contaminated were removed manually.

Other ingredients:--

The ingredients were purchased from the local market of Alexandria, Egypt, *Mentha* powder (Mint), wheat flour, sugar, salt, baking powder and other ingredients.

-Chemicals and reagents:

The purchase from the El-Gomhouria Company, Alexandria, Egypt, and Sigma – Aldrich (Germany) for reagents, solvents besides chemicals,

-Samples preparation of *Moringa* leaves:-

Moringa leaves sample preparation by washed in tap water to remove dirt .

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Next, to remove microorganisms, leaves were soaked in a one-percent saline solution (Na Cl) for five minutes. In addition, the leaves were washed with water again. This step has played a role in the removal of dust, pathogens and other than microbes available on the surface of the leaves. The leaves were air-dried (the residual moisture was evaporated at room temperature prior to the actual drying process). Oven drying, the leaves were loaded on the trays forming a single layer. The temperature was held at a steady weight of 40 ±2 ° C until to a constant weight. Then the samples that were dried were ground to powder. A sieve of aluminum (aperture 2 mm) was used to sieve the milled material. The sieved samples were collected and labeled in glass bottles (Joshi and Mehta 2010).

-Mixing of the blended samples preparation of *Mentha /Moringa* in tea bags:-

Preparation of *Mentha /Moringa* in tea bags (Stevens *et al.,* 2013) substituted by mixed the formula as follows: 100% *Mentha* (M), 99% *Mentha* + 1% *Moringa* (M 1), 97% *Mentha* + 3% *Moringa* (M 2), 95% *Mentha* + 5% *Moringa* (M 3), 93% *Mentha* + 7% *Moringa* (M 4) and 91% *Mentha* + 9% *Moringa* (M 5).

One *Mentha /Moringa* tea bags of each sample was immersed in pre-heated water at 100 ° C for 5 minutes.

-Preparation of salad using *moringa* as a spice and fortification:-

Preparation of salad using *moringa* as a spice and fortification (Stevens *et al.*, 2013) substituted by mixed the formula as follows: 100% salad (S) , 99.7% salad + 0.3% *Moringa* (S1), 99.4% salad + 0.6% *Moringa* (S2), 99.1% salad + 0.9% *Moringa* (S 3) and 98.8% salad + 1.2% *Moringa* (S 4).

-Preparation of crackers (snack) products:-

Preparation of crackers substituted with 2.5,5, 7.5 and 10% of *Moringa* powder using the method as described by Hodgman (1995). Mixed the formula (100% wheat flour (C) , 97.5% wheat flour + 2.5% *Moringa* (C 1), 95% wheat flour + 5% *Moringa* (C 2), 92.5% wheat flour + 7.5% *Moringa* (C 3) and 90% wheat flour + 10% *Moringa* (C 4). After that, added salt, butter, sugar and other ingredient were mixed in a Kenwood mixer. Also, milk was added and stirred till the dough formed and a 2-inch square cookie cutter. The crackers were baked in an oven till they were light gold, then cooled and stored at ambient temperature in a glass jar.

-Determination of proximate composition:

The samples were analysed by AOAC (2010) methods for moisture, protein, fat, ash and fiber. Moreover, the difference forms the calculated carbohydrate. Carbohydrates are measured by difference, FAO / WHO (1998) in 100 g of food as = 100 - (protein + fat + moisture + ash).

-Determination of amino acid profile:-

To the analysis of the profile was used (SYKAM S 433 Amino Acid Analyzer), to determine amino acid content of leaves sample hydrolysates was prepared following by the method of Spackman *et al*., (1958).

-Determination of fatty acid profile:-

Total lipids are extracted using a chloroform, methanol (2:1, v / v) mixture as described by Folch *et al*., (1957), by outlining the procedure of Radwan (1978) in the screw cap vial using 1% H2 SO4 in methanol under nitrogen gas current, fatty acid methyl esters of oil samples were prepared. The closed vials were heated for 90 minutes in an oven at 90 ° C.

Analysis of gas chromatographic (GC) was carried out using ACME model 6100 GC (Young LTN Instrument Co., Korea) fitted with a split / splitless injector and FID detector. Standard methyl esters of fatty acid have been used for identification.

-Determination of minerals:-

To the analysis of the minerals was used Perkin Elmer Atomic Absorption Spectrophotometer (Model 2380) to measure minerals Fe, Mg, Ca and Zn as described in the AOAC (2010). Using a flame photometer, potassium (FP 920, PG Instruments) were determined the sodium in addition to potassium using Na Cl and K Cl as the standard (AOAC, 2010), Moreover, by the Vanodo-molybdate process, phosphorus was calculated.

-Extraction of total phenolic compounds: -

The dry sample powder (10 g) was macerated for 24 hours at room temperature in absolute methanol (100 ml) according to Makkar *et al*., (2007). The extracts were filtered, then evaporated at 45 ºC using a rotary evaporator under vacuum, and weighed to determine *Moringa* leaves ' extract yield, these extracts were used.

-Determination of total phenolic content:-

The total phenolic content based on the Folin-Ciocalteu method (Singleton and Rossi, 1965) was determined in the extract.

-Determination of total flavonoid content: -

The aluminum chloride colorimetric assay as described by Zhishen *et al*., (1999) was used to determine the content of flavonoids.

-Determination of ascorbic acid:-

Ascorbic acid has been calculated using 2, 6 dicholorophenol indophenol dye as described in the AOAC (2010).

-Determination of antioxidant activity:-

The N, N Dimethyl –p – phenylenediamine dihydrochloride (DMPD) was used to measure the antioxidant activity as described by Fogliano *et al*., (1999).

-Sensory evaluation:-

Nine semi-trained panelists, students and staff of the Food Science Department, Faculty of Agriculture (Saba Basha), Alexandria University, Egypt, were used to perform the sensory evaluation. Evaluation of sensory as outlined by Tsai *et al*., (2002). In addition to the overall acceptability of all samples, sensory attributes such as appearance, colour, taste, aroma were evaluated using hedonic scales of nine points.

In the next series, the hedonic scale was: 9= Like extreme (highly), and 1= Extremely dislike. The samples were marked by three numbers and distributed at random to avoid any discrimination (Chen *et al.*, 1998). After each assessment, drinking water was provided for palate cleansing.

Statistical analysis:-

All analyses were conducted as mean and standard deviation (SD) and were expressed .Data were statistically analyses through a variance analysis (ANOVA) and significant differences were identified through Duncan's Multiple Range Test ($p \leq 0.05$) (Torrie and Steel, 1980).

RESULTS AND DISCUSSION

-Proximate composition of *M.oleifera* leaves:-

Results of the chemical analysis of MO leaves, these variations of the chemical composition may be illustrated differently in climatic environments, the period of the year and changed soil types.

Analysis of the varying portion of the *Moringa* plant (tree) may vary consist on the differences the variety of plant, cultivation method also, fertilizer addition, ripening stage as well as, the harvesting time, adding, drying method and the extraction or analytical method used (Charles *et al.*, 2011 and Rajput *et al.*, 2017).

Proximate analysis of MO leaves are displayed in Table (1). Results showed that leaves had the moisture content (7.51%), protein content was found to be (23.14%) while, crude ether extract, ash, carbohydrate and fiber were found to be (6.37, 9.35, 53.63 and 10.61%, respectively).

These results are in harmony through Gidamis *et al.*, (2003), Sanchez-Machado *et al.*, (2009) and Rajput *et al.*, (2017). Teixeira *et al*., (2014) found that, the whole MO leaf flour contained 5.4 to 11.5% fat and 8.4 to 10.9% ash. Other studies have reported changes protein contents ranging between 16 to 27.4 % (Oduro *et al.*, 2008). Finally, through data tabulated in Table (1), it can be obviously concluded that leaves are the abundant range in many significant components as protein in addition to carbohydrates.

Table 1. Proximate composition of *M.oleifera* leaves (on dry weight basis).

Components	(%)
Moisture	7.51±0.65
Crude protein[#]	23.14±0.37
Crude ether extract	6.37±0.21
Ash	9.35±0.32
Carbohydrate [##]	53.63±0.87
Fiber	10.61±0.26

The values in the table are means of the triplicates ± Standard Deviation values (SD).
Crude protein [#] (N x 6.25).
Calculated by difference on dry weight basis [##]

-Amino acid profile of MO leaves:-

Leaves had essential amino acids (AA) as suggested by the (FAO), similar patterns concerning to those of soybean (Abdulkarim *et al.*, 2005). Thurber and Fahey (2009), has also been stated that the AA profile of leaves get the values of the WHO. MO leaves have a significant amounts of all AA for children want, leading to the FAO protein reference levels (FAO/WHO (2007).

In relationship with the anti-nutritional, leaves have the lowest proportion of it (Soliva *et al.*, 2005 and Ferreira *et al.*, 2008). Amino acids content of *M. oleifera* leaves is displayed in Table (2). Table (2) clarify that moringa leaves display perfect amino acid and include 17 amino acids, nine of them are essential AA in addition to eight are non-essential amino acids. Various, percentage of essential AA such as Leucine, Lysine and Valine as follows (22.19, 15.18 and 13.79%, respectively).

In harmony with the results obtained from the current search with (Ferreira *et al.*, 2008, Newton *et al.*, 2010 and Mendieta-Araica *et al.*, 2011). It is clear from the results obtained that the *moringa* leaves approved that a perfect origin, for essential amino acids .

Table 2. Amino acid profile of MO leaves.

Amino acid	(%)
Leucine*	22.19±0.76
Lysine*	15.18±0.16
Valine*	13.79±0.23
Threonine*	11.08±0.94
Isoleucine*	10.24±0.25
Histidine*	6.69±0.63
Alanine	1.23±0.22
Aspartic acid	4.34±0.93
Serine	0.98±0.47
Proline	0.86±0.84
Glutamic acid	5.44±0.75
Phenylalanine*	1.15±0.13
Arginine*	1.92±0.34
Methionine*	0.80±0.13
Tyrosine	0.91±0.28
Cysteine	0.93±0.13
Glycine	0.97±0.16

Mean values ± Standard Deviation values.
Indicate essential amino acid*

Fatty acid profile of MO leaves: - -

The leaves profile of fatty acid (FA) is shown in Table (3). Data indicated that the major FA in MO leaves were oleic acid ($C_{18:1}$) (40.24%), linolenic acid ($C_{18:2}$) (19.43%), palmitic acid($C_{16:0}$) (15.63%) in addition to linoleic acid ($C_{18:2}$) (7.95 %).As regards the oil stability, *Moringa* leaves oil is more stable due to its rise content of oleic acid. These results are harmony through Sanchez-Machado *et al.*, (2009) who found that *moringa* leaves contained high amounts of palmitic acid, linoleic acid, linolenic acid and oleic acid representing about 90% of the total FA. The proportion of unsaturated to saturated FA 3.21%. This result means the total unsaturated FA was higher than those of saturated ones. This proportion is more than the popular vegetable oils. From these results, *moringa* leaves oil appears to be highly important for human nutrition, because of monounsaturated FA as an abundant diet can regulate the low density of lipoproteins and total cholesterol levels as olive oil. In harmony with the results have been obtained with (Amaglo *et al.*, 2010, Olagbemide and Philip, 2014 and Gopalakrishnan *et al.*, 2016). Sanchez-Machado *et al.*, (2009) it was reported that linolenic, palmitic, linoleic and oleic acids were the main FA in MO leaf oil.

Table 3. Fatty acid profile (%of total fatty acid) of MO leaves.

Fatty acids	%
Myristic acid ($C_{14:0}$)	3.23 ±0.75
Palmitic acid ($C_{16:0}$)	15.63±0.24
Stearic acid ($C_{18:0}$)	3.93±0.32
Arachidic acid ($C_{20:0}$)	0.89 ±0.25
SFA	23.68±0.22
Palmitolic ($C_{16:1}$)	3.54 ±0.43
Oleic acid ($C_{18:1}$)	40.24±0.54
Linoleic acid ($C_{18:2}$)	7.95 ±0.44
Linolenic acid ($C_{18:3}$)	19.43±0.78
Gondoic acid ($C_{20:1}$)	4.91 ±0.15
USFA	76.07±0.19
USFA/ SFA	3.21

Mean values ± Standard Deviation values.
SFA: Saturated fatty acid, USFA: Unsaturated fatty acid

-Elemental analysis of MO leaves:-

The micronutrients of any plant consist of various physical characteristic of the soils contain specific qualities and quantities of mineral elements that rely on soil properties

for bioavailability (pH and clay properties). (Nambiar and Seshadri 2001). The element's content of MO leaves are presented in Table (4).

Results indicate that Ca, K, P, Na in addition Mg were the major elements, moreover, microelements such as Fe and Zn were found in considerable amount. In agreement with the results obtained that in the current search with (Teixeira *et al.,* 2014 and Rajput *et al.,* 2017). It is clear that Moringa leaves contained consider concentrations of mineral.

Table 4. Mineral content of MO leaves.

Mineral	Concentration (mg/100g)
Macro - elements	
Calcium (Ca)	1233.33±0.19
Potassium (K)	1024.55 ±0.67
Sodium (Na)	295.28±0.35
Phosphorus (P)	207.62 ±0.31
Magnesium (Mg)	205.64±0.85
Micro – elements	
Iron (Fe)	37.47±0.16
Zinc (Zn)	5.23±0.12

Mean values ± Standard Deviation values.

-Total phenolics, flavonoids, ascorbic acid besides antioxidant activity in M O leaves:-

Moringa oleifera dried leaves are a perfect level of polyphenols and range from 20 to 122 mg GAE/g. The several environmental statuses in some countries as the season, the drying method, the leaf maturity and the method of extraction used, may explain such a wide range of values as reported by Sreelatha and Padma (2009). Luqman *et al.,* (2012) stated that the phenolic content was raised with an increase of manner. Otherwise, Joshi and Metha (2010) noticed that there were losses of ascorbic acid with the drying of fresh leaves. Total phenolic, flavonoids and ascorbic acid content in MO leaves are presented in Table (5). Data presented that the phenolic content was found (33.12 mg GAE/g extract), flavonoids content (18.12 mg/g) and ascorbic acid content (17.67 mg/100g).

These results are in harmonization with, Gupta *et al.,* (2008), Adefegha and Oboh (2011), Djuikwo *et al.,* (2011) and Agamou *et al.,* (2015). However,the antioxidant activity was (78.98%), in harmony with the results obtained with, Wangcharoen and Gomolmanee (2013) and Saini *et al.,* (2014). Moreover, Vongask *et al.,* (2013) suggested that, in addition to flavonoids, the phenolic content is the main active ingredients that induce potent antioxidant activity. Phenolic complex besides flavonoids, in special, are provided with antioxidant activity, and play a major role in scavenging free radicals and in the inhibition of lipids peroxidation (Blumberg *et al.,* 2015).

Table 5. Total phenolic, flavonoids, ascorbic acid and antioxidant activity in of MO leaves.

Component	Concentration
Total phenolic content(mg GAE/g)[#]	33.12±0.23
Total flavonoids(mg/g)[##]	18.12±0.89
Ascorbic acid (mg/100g)	17.67±0.95
Antioxidant activity (%)	78.98 ±0.65

Mean values ± Standard Deviation values
Milligram gallic acid equivalent per gram of extract[#].
Milligram catechol equivalents per gram of extract. [##]

-Sensory properties of some foodstuff products:-

In general, preparing of some foodstuff including blending ratio of *Mentha /Moringa* in tea bags, snack (crackers) food besides preparing the salad as a spice that contains different concentrations of MO leaf powder were displayed as follows**:-**

-Sensory evaluation of *Mentha /Moringa* in tea bags:-

Herbal tea is actually mixtures of several ingredients. They taste great, too, and they are easy to drink. More research on the potential of indigenous plant materials in the development of new herbal tea is therefore imperative. (Aoshima *et al.,* 2007). The related of *M. Oleifera* has perfect nutritional quality. Food fortification includes the supplement of essential nutrients as minerals besides vitamins to increase their nutritional value (Sanchez-Machado *et al.,* 2009).

The result of *Mentha*/*moringa*'s sensory attributes qualities in sample blends of tea bags are displayed in Table (6). From the obtained results, it can be detected that *mentha /moringa* sample (M2) had the best chosen followed by (M3) but not significantly different ($P \leq 0.05$). According to panelists assessment of the samples, the control (M) is also preferable when compared with the sample (M 5), in relationships of overall acceptability.

These results are in harmony with Tsai and Huang (2004). A reason for the low of overall acceptability of the sample (M 5) might be as a result of a rise in the ratio of the *moringa* to the *mentha* (Fasoyiro *et al.,* 2005). Results from the sensory assessment displayed that sample (M2) Due to the positive influence of the *moringa* on the sensory attributes, it was preferred to others.

Table 6. Mean sensory evaluation score of *mentha /moringa* in tea bags.

Sample	Colour	Aroma	Taste	Appearance	Over all acceptability
M	6.20±0.73^{c}	6.10±0.45^{c}	6.10±0.26^{c}	6.30±0.65^{c}	6.20±0.64^{c}
M1	6.40±0.89^{c}	6.20±0.61^{c}	6.30±0.19^{c}	6.60±0.54^{c}	6.50±0.79^{c}
M2	8.50±0.84^{a}	8.40±0.74^{a}	8.50±0.28^{a}	8.70±0.39^{a}	8.60±0.11^{a}
M3	8.40±0.22^{a}	8.20±0.92^{a}	8.30±0.30^{a}	8.60±0.56^{a}	8.50±0.43^{a}
M4	7.70±0.37^{b}	7.50±0.33^{b}	7.60±0.13^{b}	7.80±0.95^{b}	7.80±0.84^{b}
M5	5.50±0.84^{d}	5.40±0.23^{d}	5.50±0.28^{d}	5.70±0.78^{d}	5.60±0.76^{d}

Mean values represent ± Standard Deviation values.
Mean values with different superscripts within the same column are significantly different ($p \leq 0.05$).
100% *Mentha* (M), 99% *Mentha* + 1% *Moringa* (M 1), 97% *Mentha* + 3% *Moringa* (M 2), 95% *Mentha* + 5% *Moringa* (M 3), 93% *Mentha* + 7% *Moringa* (M 4) and 91% *Mentha* + 9% *Moringa* (M 5).

-Sensory evaluation of prepared salad using moringa as a spice and fortification:-

As regard to food fortification by legumes takes a valuable place in human food.

Legume consuming has been related to the reduction of cardiovascular diseases, diabetes and hypertension (Kris-Etherton *et al.,* 2002). Moreover, the increase in food allergies has resulted in the use of legumes as a nutrient-rich alternative to common allergens such as gluten and eggs. (Boye *et al.,* 2010). *Moringa* leaves is used in preparing the vegetable salad and use as a spice (Stevens *et al.,* 2013).

The mean of the sensory score of salad made from *moringa* as a spice and fortification with different ratio of *moringa* was presented in Table (7). Results displayed that there were significant variances in overall acceptability of salad among the control sample and all the other blends with *M.oleifera*. Form the results, it can be detected that the salad /*moringa* sample (S2) had more favored followed by (S1).

The amount of *moringa* had a positive effect on colour, odour, and taste in addition to overall acceptability. Similar, these results are harmony with Stevens *et al.,* (2013).

Table 7. Mean sensory evaluation score of salad using *M. oleifera* leaves as a spice.

Sample	Colour	Odour	Taste	Texture	Over all acceptability
S	7.40±0.62^{c}	7.50 ±0.12^{c}	7.40 ±0.16^{c}	7.50±0.34^{c}	7.40 ±0.75^{c}
S1	8.00±0.98^{b}	8.10 ±0.44^{b}	8.00 ±0.52^{b}	8.10±0.14^{b}	8.00 ±0.26^{b}
S2	8.70±0.42^{a}	8.70 ±0.61^{a}	8.60 ±0.21^{a}	8.70±0.85^{a}	8.60 ±0.39^{a}
S3	6.70±0.11^{d}	6.80 ±0.67^{d}	6.70 ±0.87^{d}	6.60±0.38^{d}	6.50 ±0.54^{d}
S4	5.80±0.92^{e}	5.90 ±0.77^{e}	5.60 ±0.36^{e}	5.70±0.71^{e}	5.70 ±0.42^{e}

Mean values represent ± Standard Deviation values.
Mean values with different superscripts within the same column are significantly different (p≤ 0.05)
100% salad (S) , 99.7% salad + 0.3% *Moringa* (S1), 99.4% salad + 0.6% *Moringa* (S2), 99.1% salad + 0.9% *Moringa* (S 3) and 98.8% salad + 1.2% *Moringa* (S 4).

-Sensory evaluation of crackers (snack) products:-

In addition to the sensory quality in cookies, the characteristic of wheat flour substitution with legume flours such as chickpea flours on the physicochemical is reported through (Aziah *et al*., 2012). It was also reported that the protein quantity of cookies made from chickpea compound flours was higher compared to wheat flour cookies. Table (8) presents the result of the sensory attributes qualities of the test blends of crackers. The crackers sample (C 2) had the best preference followed by (C 1). But it can be found from these results, not significantly different (P≤ 0.05). In order to be generally acceptable, the statistical data study showed significant differences between all cracker samples and control samples (P≤ 0.05). According to the sample assessment panelists, control (C) is also preferable when compared to the sample (C 4) in terms of overall acceptability. These results are in harmony with Aziah *et al.*, (2012) who stated that the sensory value, of cookies legume-based were valued high in flavour, colour besides overall acceptability with the significant difference in comparison to the control cookies.

Ogunsina *et al.*, (2011) assessed the quality attribute of *moringa* flour-enhanced cookies and reported that up to 30 percent of *moringa* flour was influenced by the value of cookies by the substitution of wheat flour. In terms of nutritional quality, the cookies were found to have a higher protein, mineral content, and it was also proposed that the use of *moringa* in bakery products could be used as a unique way of perfecting food in developing countries where malnutrition is one of the serious issues that should be resolved quickly (Fuglie, 2005).

Table 8. Mean sensory evaluation score of crackers (snack) made from wheat flour with different ratio of *M. oleifera* leaves.

Sample	Colour	Odour	Taste	Texture	Over all acceptability
C	7.80±0.63^{b}	7.90 ±0.22^{b}	7.70 ±0.67^{b}	7.70±0.62^{b}	7.70 ±0.34^{b}
C1	8.50±0.52^{a}	8.70 ±0.74^{a}	8.40 ±0.32^{a}	8.50±0.90^{a}	8.40 ±0.77^{a}
C2	8.70±0.43^{a}	8.80 ±0.72^{a}	8.60 ±0.11^{a}	8.60±0.82^{a}	8.60 ±0.49^{a}
C 3	6.90±0.24^{c}	6.80 ±0.71^{c}	6.70 ±0.98^{c}	6.70±0.26^{c}	6.70 ±0.21^{c}
C 4	5.70±0.15^{d}	5.80 ±0.54^{d}	5.60 ±0.63^{d}	5.60±0.66^{d}	5.60 ±0.98^{d}

Mean values represent ± Standard Deviation values.
Mean values with different superscripts within the same column are significantly different (p≤ 0.05)
100% wheat flour (C) , 97.5% wheat flour + 2.5% *Moringa* (C 1), 95% wheat flour + 5% *Moringa* (C 2), 92.5% wheat flour + 7.5% *Moringa* (C 3) and 90% wheat flour + 10% *Moringa* (C 4).

CONCLUSION

Moringa is evaluated as a nutrient-rich plant moreover, the obtained results in this investigation indicates that the leaves have a major nutritional value as fat, protein and fibers. Also, *Moringa* leaves are rich in many important elements such as (Ca, K, P, Fe and Zn), source for essential AA in addition to FA besides high content of phytochemicals, phenolic compounds, which showing as natural oxidants. Sensory evaluation of application enriched with *Moringa* oleifera for potential using the part in foodstuff confirmed that can become applied as food additives or food fortification. Therefore, recommend improving the consumption from it to treat protein malnutrition in developing countries.

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استخدام أوراق المورينجا في بعض التطبيقات الغذائيه

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الهدف من هذه الدراسة هو التحليل الكيميائي بالإضافة إلى خصائص ا ستخدام أوراق المورينجا المصريه في التطبيقات الغذائيه . أظهرت نتائج التحليل الكيميائي لأوراق المورينجا انها غنيه بالبروتينات والكربوهيدرات والألياف (٢٣.١٤ ، ٥٣.٦٣ ، ١٠.٦١ ٪ ، على التوالي). و مصدرا جيدا للأحماض الأمينية الأساسية مثل leucine و lysine و valine كما يلي (٢٢.١٩ ، ١٥.١٨ و ١٣.٧٩ ٪ ، على التوالي) .كما أظهر تحليل الأحماض الدهنية أن حمض اللينولينيك يمثل ($C_{18:2}$) (١٩.٤٣ ٪) ، و حمض البالميتيك ($C_{16:0}$) (١٥.٦٣ ٪) وكذلك حمض اللينوليك ($C_{18:2}$) (٧.٩٥ ٪) مما يدل علي القيمه الغذائيه العاليه بالاضافه الي ذلك انها غنيه با لعناصر المعدنيه مثل الكالسيوم و البوتاسيوم.أظهرت النتائج أيضًا أن اوراق المورينجا هي من المصادرالوفيرة للمركبات النشطة حيويا ومضادات الأكسدة (محتوى الفينول (٣٣.١٢ ملليجرام GAE / جم) ، محتوى الفلافونويد (١٨.١٢ ملج / جم) ، محتوى حمض الأسكوربيك (١٧.٦٧ ملجم / ١٠٠ جم) ونشاط مضادات الأكسدة (٧٨.٩٨٪). بشكل عام ، اظهرت التقيمات الحسية للتطبيقات المدعمه بأوراق المورينجا المجففه امكانيه استخدامها باكثر من تطبيق. أظهرت أفضل التقييمات الحسية أن *Mentha* / *Moringa* في أكياس الشاي كانت (٩٧ ٪ *Mentha* + ٣٪ *Moringa*) ، وكانت السلطة المعدة باستخدام *Moringa* كتوابل وتدعيم (٩٩.٤ ٪ سلطة + ٠.٦ ٪ *Moringa*) و منتجات المقرمشات (٩٥٪ من دقيق القمح + ٥٪ *Moringa*). نتيجة لذلك يجب التوسع في استخدامها غذائيا لعلاج سوء التغذية وخاصه في البلدان النامية.