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Research Article

# Utilization of *Moringa oleifera* Leaves Powder in Production of Yoghurt

Fatma A.M. Hassan, Hala M. Bayoumi, Mona A.M. Abd El-Gawad, A.K. Enab and Y.B. Youssef

Department of Dairy, National Research Centre, Dokki, Cairo, Egypt

## Abstract

*Moringa oleifera* leaves contain high amount of vitamin B complex, potassium, iron protein and they contain all of the essential amino acids in good proportion so it's used to improve the nutritional and sensory evaluation of food products by incorporating its extract into food products. Different ratios of *Moringa oleifera* leaves powder (0.5, 1, 1.5 and 2%) was used in production of yoghurt and the best ratio was storage at 5±1°C for 7 and 15 days then analyzed for sensory evaluation and chemical properties fresh and during cold storage at 5±1°C. Results show that 0.5% was a best ratio and gained highest score for flavor as well as taste. Treatment had higher content of total solids, fat, total protein, soluble nitrogen, total volatile fatty acids , acetaldehyde, diacetyl and lower pH than control fresh and during cold storage at 5±1°C whereas, control had higher viscosity than treatment fresh and during cold storage. Colour was preferred in control it had a higher whiteness than treatment either fresh or during cold storage. Treatment had a highest content of alanine acid, glutamine and tyrosine and had lowest content of cysteine, methionine as well as histidine. Moringa leaves contained 17 amino acid.

Key words: Yoghurt, *Moringa oliefera*, leaves amino acids, nutrition, Moringa yoghurt

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Corresponding Author: Fatma A.M. Hassan, Department of Dairy, National Research Centre, Dokki, Cairo, Egypt



Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

*Moringa oleifera* lam (Syn. Moringa pteygospema) is a member of the Moringaceae family which is a single genus family of shrubs Jahn (1984) and Ndabigengesere *et al.* (1995). It is a fast growing tree and can tolerate draught, sandy soil, bacteria and fungi.

It is widely cultivated in Africa, Central and South America, Sirlanka, India, Mexico, Malaysia, Indonesia and the Philippines (Jongrungruangchok *et al*., 2010).

*Moringa oleifera* is referred to as a "Miracle tree" or "Wonder tree" (Kasolo *et al*., 2010) of significant socio economic importance because of its several nutritional, pharmacological (Caceres *et al*., 1991) and industrial application (Makkar and Becker, 1997; Foidl *et al*., 2001). The leaves of this plant contain high amount of vitamin B complex, calcium, potassium, iron and protein. Also, they contain all of the essential amino acids in good proportion (Mishra *et al*., 2012).

*Moringa oleifera* is known for long time as an important nutritional supplement with a variety of medicinal properties. It is proved by research work that *Moringa oleifera* leaves extracts is good to regulate the hyperthyroidism (Tahiliani and Kar, 2000) it works as hypocholestrolemic agent in obese patients (Ghasi *et al*., 2000).

Antiproliferation and induction of a ptosis on human cancer cell Sreelatha *et al.* (2011). It works as antifungal beside the use of its essential oil for anti-skin diseases agent Chuang *et al*. (2007). *Moringa oleifera* leaves works as antioxidant (Chumark *et al*., 2008).

Different extracts of *Moringa oleifera* leaves are active against bacteria such as: *E. coli*, *S. arous*, *P. aeruginosa* and *B. cereus* as these organisms range from pathogenic and toxigenic organism liable to cause food borne illnesses and food spoilage due to bacteria presence.

It can be used as evaluable drug in the treatment of infections caused by *E. coli*, typhid and *P. aekuginosa* (Abalaka *et al*., 2012).

Moringa leaves are extensively utilized to improve the nutritional and sensory evaluation by incorporating its extract into food products like sauces, Juices, species, milk, bread (Mukunzi *et al*., 2011).

The aim of this study was to evaluate the influence of *Moringa oleifera* leaves on sensory evaluationand chemical properties of yoghurt fresh and during cold storage and improve the nutritional value of yoghurt.

## MATERIALS AND METHODS

Fresh buffaloe's milk was obtained from the herd of the Faculty of Agriculture, Cairo Univ., Giza.

*Moringa oleifera* leaves obtained from Moringa Laboratory at National Research Centre. It contains 27.1/100 g protein, 2.3/100 g fat, moisture 7.5%, carbohydrate 38.2%/100 g and fiber 19.2/100 g.

**Preparation of Moringa:** Moringa leaves dried and made into powder by rubbing them over a sieve and the leaf powder stored in plastic container.

**Culture:** Pure cultures were obtained from Chr. Hansens Laboratories, Copenhangen, Denmark. The cultures were: *S. salivaricus* subsp. *thermophilus* and *L. delbruechii* subsp. *bulgaricus*. Cultures were propagated in sterile skim milk at 37°C.

**Preparation of yoghurt:** Buffaloe's milk was divided into five portions. First was applied as control and second, third, fourth and fifth were incorporating with. 0.5, 1, 1.5 and 2%, respectively with Moringa leaves powder then they were heated at 85°C for 15 min, cooled to 45°C, inoculated with 2% starter culture (*S. thermophilus+L. bulgaricus* 1:1) incubated at 45°C until coagulate. The coagulate was held in refrigerator at (5±1°C) for 15 days. Samples were analyzed fresh and during cold storage (7, 15 days) for sensory evaluation and chemical properties.

**Preliminary study:** The resultant yoghurt with different concentrations (0.5, 1, 1.5 and 2%) of *Moringa oleifera* leaves was evaluated by a panel of staff members at dairy laboratory N.R.C. to choose the best concentration. The best concentrations were analyzed fresh and during cold storage at 7, 15 days for sensory evaluation.

**Analytical methods:** Total solids, total protein and soluble nitrogen were determined according to AOAC (2007). The pH values were measured using a digital laboratory pH meter (HI 93/400, Hanna instruments) with glass electrode. Acetaldehyde and diacetyl contents were estimated according to Lees and Jago (1970). Total Volatile Fatty Acids (TVFA) contentwere determined according to Kosikowski (1987), total amino acids according to Marino *et al.* (2010) colour change of yoghurt manufactured by using 0.5% *Moringa oliefera* leaves powder fresh and during cold storage at 5±1°C was measured using a spectrocolorimeter (Tristimulus Color Machine) with the CJE Lab Color Scale (Hunter, Lab Scan

XE-Restos VA, USA) in the reflection mode. The color was expressed in terms of L, a and b. where, L value represents darkness from black (0) to white (100), a value represent color ranging from red (+) to green (-), b value represent yellow (+) to blue (-).

**Viscosity:** Determined using a brook field synchro-lectric viscometer (Model LVT; Brook field Engineering Inc. Stoughton, MA). Reading was taken at the speed of 4-60 $sec^{-1}$ using spindle -04 at 7°C viscosity were expressed as poise.

**Sensory evaluation:** Sensory evaluation was carried out for all treatments using score scheme (20, 40, 20 and 20) for appearance flavor, taste and colour respectively by a panel of 20 trained Judges of staff members, at Dairy Laboratory N.R.C.

**Statistical analysis:** Statistical analysis was carried out using SAS (2004) software and probability of ($p<0.05$) was used to establish statistical significance.

## RESULTS AND DISCUSSION

Table 1 evaluates sensory evaluation properties of yoghurt manufactured by suing different ratios of *Moringa oliefera* leaves powder. Control had gained highest score in appearance, flavor, test and colour than other treatments followed by treatment with 0.5 and 1% of *Moringa oliefera* leaves powder. Finally with 1.5 and 2%, respectively preliminary study show that yoghurt manufactured by 0.5% *Moringa oliefera* leaves powder was best ratio and had a good appearance, flavour, taste and colour than other treatments.

So yoghurt manufactured by using 0.5% *Moringa oliefera* leaves powder was storage at 5±1°C for 15 days and analyzed for sensory evaluation and chemically properties fresh and during storage.

Table 2 shows sensory evaluation of yoghurt manufactured by using 0.5% *Moringa oliefera* leaves powder fresh and during cold storage at 5±1°C for 7 and 15 days.

It was clear that control had gained a highest score for appearance and colour than treatment either fresh or during cold storage at 5±1°C for 7 and 15 days. Scores gradually decreased during cold storage until 15 days for appearance and colour. On the other hand, flavor and taste had gained a highest score in treatment than control and took the same trend of appearance and colour during cold storage at 5±1°C for 7 and 15 days. However the flavor and taste of the treatments were preferred. There were significantly different ($p<0.05$) between storage period and treatment.

Table 1: Sensory evaluation of yoghurt manufactured by using different ratios of *Moringa oliefera* leaves powder

| MOLP (%) | Appearance (20) | Flavour (40) | Taste (20) | Colour (20) | Total (100) |
|---|---|---|---|---|---|
| Control | 18.71 | 37.57 | 18.41 | 18.28 | 92.97 |
| 0.5 | 17.28 | 37.71 | 18.57 | 16.71 | 90.27 |
| 1 | 15.32 | 33.52 | 15.05 | 14.37 | 78.26 |
| 1.5 | 14.56 | 30.40 | 12.46 | 12.56 | 69.98 |
| 2 | 9.18 | 28.50 | 10.53 | 9.75 | 57.76 |

MOLP: *Moringa oliefera* leaves powder

Table 2: Sensory evaluation of yoghurt manufactured by using 0.5% *Moringa oliefera* leaves powder fresh and during cold storage at 5±1°C

| Properties | Storage period ($days^{-1}$) | Control | Treatments | ±SE |
|---|---|---|---|---|
| Appearance (20) | Fresh | $18.71^a$ | $17.28^a$ | 0.392 |
| | 7 | $18.28^a$ | $17.00^a$ | 0.317 |
| | 15 | $18.18^a$ | $16.71^b$ | 0.327 |
| Falavour (40) | Fresh | $37.57^a$ | $37.71^a$ | 0.653 |
| | 7 | $36.14^a$ | $36.72^a$ | 0.321 |
| | 15 | $35.85^a$ | $36.28^a$ | 0.421 |
| Taste (20) | | | | |
| | Fresh | $18.14^a$ | $18.57^a$ | 0.274 |
| | 7 | $18.00^a$ | $17.28^b$ | 0.248 |
| | 15 | $16.71^a$ | $16.73^a$ | 0.234 |
| Colour (20) | Fresh | $18.28^a$ | $16.71^a$ | 0.291 |
| | 7 | $18.14^a$ | $16.42^b$ | 0.280 |
| | 15 | $18.00^a$ | $16.35^a$ | 0.327 |

$^{a,b}$Dissimilar superscripts at the same row (for treatments) and the same column (for storage periods) are significantly differed ($p<0.05$)

Table 3: Chemical composition of yoghurt manufactured by using 0.5% *Moringa oleifera* leaves powder fresh and during cold storage at 5±1°C

| Properties | Storage period ($days^{-1}$) | Control | Treatments | ±SE |
|---|---|---|---|---|
| TS (%) | Fresh | $18.46^b$ | $18.73^a$ | 0.0632 |
| | 7 | $18.63^a$ | $18.86^b$ | 0.0562 |
| | 15 | $18.83^a$ | $18.96^a$ | 0.0440 |
| Fat (%) | Fresh | $6.00^a$ | $6.10^a$ | 0.0210 |
| | 7 | $6.10^b$ | $6.02^a$ | 0.0210 |
| | 15 | $6.20^b$ | $6.03^a$ | 0.0220 |
| pH | Fresh | $4.78^a$ | $4.72^b$ | 0.0120 |
| | 7 | $4.55^a$ | $4.51^b$ | 0.0070 |
| | 15 | $4.44^a$ | $4.41^b$ | 0.0220 |
| TP (%) | Fresh | $6.91^b$ | $7.10^a$ | 0.3790 |
| | 7 | $6.92^b$ | $7.15^a$ | 0.4020 |
| | 15 | $6.95^b$ | $7.17^a$ | 0.4180 |

$^{a,b}$Dissimilar superscripts at the same row (for treatments) and the same column (for storage periods) are significantly differed ($p<0.05$), Each value is a mean of 3 replicates, TS: Total solids and TP: Total protein

These results were in agreement with Madukwe *et al.* (2013) who reported that colour of the control was preferred over Moringa beverage and Moringa beverage was more acceptable than lipton (control) in terms of flavor and overall acceptability.

Flavour and taste for treatment were preferred. This may be due to the nutrient composition of *Moringa oliefera* leaves powder.

Table 3 illustrates the chemical composition of yoghurt manufactured by using 0.5% *Moringa oleifera* leaves powder fresh and during cold storage at 5±1°C.

**Total solids:** Treatment had a highest content (TS) than control either fresh or during cold storage at 5±1°C for 7 and 15 days. The degrees increased gradually during cold storage 5±1°C until 15 days in both control and treatment. This refers to the composition of *Moringa oleifera* leaves.

**Fat content:** From the same table it notices that treatment had nearly similar content of fat than control fresh and during cold storage. Mensah *et al*. (2012) reported that the fat value in Moringa is higher than 0.5%.

The pH took an opposite trend of acidity in control and treatment either fresh or during cold storage at 5±1°C. Control had a higher pH than treatment either fresh or during cold storage.

**Total protein:** The result evaluated that treatment had a highest content of total protein than control either fresh or during cold storage (5±1°C) and gradually increased during cold storage (5±1°C) until 15 days. This refers to composition of *Moringa oleifera* leaves powder.

This results nearly same to Sodamode *et al*. (2013), who reported that in solanum microcapor leaves protein concentrates greater than 8.44±0.05%.

This means that leaf protein concentrates could be used as nutritionally valuable healthy ingredient to improve protein deficiency of man or animal diet. There are significant differences ($p<0.05$) between the treatment and storage period for TS, fat, pH and TP.

Table 4 Indicate soluble nitrogen in yoghurt manufactured by using 0.5% *Moringa oleifera* leaves fresh and during cold storage at 5±1°C. It is clear that treatment had a highest content of soluble nitrogenthan control either fresh or during cold storage. Soluble nitrogen gradually increased during cold storage at 5±1°C until 15 days in both control and treatment. These results were in agreement to Ismail *et al*. (2006). Statistical analysis show significant differences ($p<0.05$) between control and treatment fresh and during cold storage.

Table 4 show Total Volatile Fatty Acids (TVFA) in both control and treatment fresh and during cold storage at 5±1°C.

Treatment had a highest TVFA than control either fresh or during cold storage 5±1°C this may be due to the composition of Moringa leaves or to the proteolysis as amino acids can serve as precursors for the development of certain volatile fatty acids (Salem *et al*., 2007) TVFA gradually increased during cold storage at 5±1°C until 15 days either control or treatment. Statistical analysis shows a significant difference at ($p<0.05$).

Table 4: Soluble nitrogen (%) and total volatile fatty acid in yoghurt manufacture by using 0.5% *Moringa oleifera* leaves powder

| Properties | Storage period (day$^{-1}$) | C | T | ±SE |
|---|---|---|---|---|
| SN (%) | Fresh | 2.21$^{b}$ | 2.32$^{a}$ | 0.038 |
| | 7 | 2.53$^{b}$ | 2.60$^{a}$ | 0.027 |
| | 15 | 2.84$^{b}$ | 3.10$^{a}$ | 0.066 |
| TVFA | Fresh | 9.76$^{b}$ | 11.90$^{a}$ | 0.503 |
| | 7 | 12.33$^{b}$ | 14.00$^{a}$ | 0.393 |
| | 15 | 16.01$^{b}$ | 18.05$^{a}$ | 0.414 |

TVFA: Total volatile fatty acid (0.1 N NaOH mL/100 g), $^{a, b}$Dissimilar superscripts at the same row (for treatments) and the same column (for storage periods) are significantly differed ($p<0.05$), Each value is a mean of 3 replicates and SN: Soluble nitrogen

Table 5: Acetaldehyde and diacetyl content (mmol/100 g) of yoghurt manufacture by using 0.5% *Moringa oleifera* leaves powder

| Treatments | Storage period (day$^{-1}$) | Acetaldhyde contents | Diacetyl contents | ±SE |
|---|---|---|---|---|
| C | Fresh | 6.60$^{a}$ | 8.26$^{a}$ | 0.571 |
| | 7 | 11.40$^{a}$ | 8.33$^{b}$ | 0.225 |
| | 15 | 18.00$^{a}$ | 8.96$^{b}$ | 0.256 |
| T | Fresh | 9.65$^{b}$ | 9.23$^{b}$ | 0.125 |
| | 7 | 11.60$^{b}$ | 9.33$^{a}$ | 0.249 |
| | 15 | 18.73$^{b}$ | 9.80$^{a}$ | 0.312 |

C: Control, T: Treatment, Dissimilar superscripts at the same row (for treatments) and the same column (for storage periods) are significantly differed ($p<0.05$)

Table 5 indicate acetaldehyde and diacetyl (mmol/100 g) content in yoghurt manufacture by using 0.5% *Moringa oleifera* leaves powder. Treatment had a highest content of acetaldehyde than treatment either fresh or during cold storage at 5±1°C. Acetaldehyde gradually increased during cold storage 5±1°C until 15 days either control or treatment. These results are in agreement to Salem *et al*. (2007).

Table 5 show diacetyl content in control and treatment fresh and during cold storage at 5±1°C. It took the same trend of acetaldehyde fresh and during cold storage at 5±1°C.

Figure 1 illustrate the viscosity of yoghurt manufactured by using 0.5% *Moringa oliefera* leaves powder fresh and during cold storage at 5±1°C. Control had higher viscosity than treatment fresh and during cold storage. Viscosity gradually increase until 15 days either control or treatment. Increase viscosity may be due to increase acidity during storage.

Table 6 shows change of colour of yoghurt manufactured by using 0.5% *Moringa oliefera* leaves powder fresh and during cold storage. It is clear that control had higher whiteness than treatment either fresh or during cold storage. Whiteness decreased gradually during cold storage in both control and treatment until 15 days. These results were in agreement to Hassan (2000), who reported that colour change decreased during storage. On the other hand (a), (b) took opposite trend of L during cold storage for control and

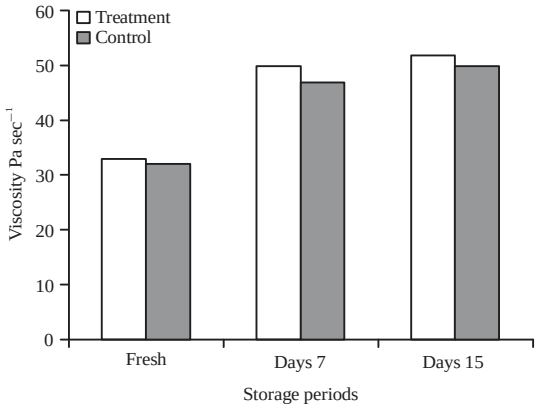


Fig. 1: Viscosity of yoghurt manufactured by using 0.5% *Moringa oleifera* leaves powder fresh and during cold storage

Table 6: Colour of yoghurt manufacture by sing 0.5% *Moringa oliefera* leaves powder fresh during cold storage

| Samples | L | a | b |
|---|---|---|---|
| **Fresh** | | | |
| C | 94.39 | -2.03 | 9.44 |
| T | 80.81 | -1.90 | 13.68 |
| **7 days** | | | |
| C | 94.35 | -2.21 | 9.55 |
| T | 80.37 | -1.96 | 15.01 |
| **15 days** | | | |
| C | 94.26 | 2.22 | 10.03 |
| T | 80.30 | 1.87 | 15.45 |

L: Darkness from black (0) to white (100), a: Colour ranged from red (+) to green (-), b: Value represent yellow (+) to blue (-), C: Control and T: treatment

Table 7: Amino acids composition of dried *Moringa oleifera* leaves and resultant yoghurt with 0.5% Moringa oleifera leaves powder

| Amino acids | Leaf (%) | Yoghurt (%) |
|---|---|---|
| Arginine | 1.699 | 1.982 |
| Serine | 1.043 | 1.326 |
| Aspartic acid | 1.374 | 1.706 |
| Glutamic acid | 2.340 | 2.954 |
| Glycine | 1.487 | 1.667 |
| Thereonine | 1.385 | 1.653 |
| Alanine | 2.980 | 3.240 |
| Tyrosine | 2.540 | 2.980 |
| Proline | 1.189 | 1.321 |
| Methionine | 1.100 | 0.120 |
| Valine | 1.398 | 1.420 |
| Phenylalanine | 1.590 | 1.925 |
| Isoleucine | 1.159 | 1.543 |
| Leucine | 1.890 | 2.590 |
| Histidine | 0.696 | 1.342 |
| Lysine | 1.599 | 1.985 |
| Cysteine | 0.100 | 0.103 |

treatment. The L. values were in agreement to Khader *et al*. (1997) and El-Shibiny *et al*. (2013).

Table 7 illustrate amino acids profile of yoghurt manufactured by using 0.5% *Moringa oleifera* leaves powder. Yoghurt had a highest content of alanine acid (3.240%) followed by glutamic (2.954) and tyrosine (2.980%) and had a lowest content of cysteine, methionine and histidine.

The variations in the amino acids composition could be influenced by protein quality and the origin of the plant (cultivated or wild) (Sanchez-Machado *et al*., 2010). He also reported that leucine in leaves having highest value of 1.75%, which is lower than our findings (1.890%).

In this study, dried Moringa leaves contained 17 amino acids which differ from the findings of Foidl *et al*. (2001) and Sanchez-Machado *et al*. (2010), who reported 18 and 16 amino acids, respectively.

## CONCLUSION

The 0.5% of *Moringa oleifera* leaves powder was a best ratio in production of yoghurt. This ratio improves the nutritional value and sensory evaluation and chemically properties, of resultant yoghurt.

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