Physicochemical analysis of yogurt fortified with Moringa Oleifera leaf powder

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Abstract

Moringa oleifera is is termed as life plant, miracle plant and multi-purpose plant for having several nutritional, pharmacological and industrial applications. It is used to make a novel fermented bio-product that is nutritionally rich and enhances the functionality of mango flavored yogurt. The effect of four different concentrations of moringa dried leaf powder are used during the production of mango flavored yogurt and analyzed for its physicochemical properties (pH, acidity, fat%, total soluble solids, moisture% ash%, fiber% and syneresis) and sensory characteristics. Results show that mango flavored yogurt fortified with 1% leaf powder of moringa oleifera has got highest score in majority of the sensory attributes over the storage period of 15 days at 5ºC. All treatments showed significantly (p [?] 0.05) higher results for acidity, total soluble solids, protein & syneresis as compared to control treatment during fresh and storage period. While, all treatments showed less pH and moisture content than control and fat was nearly same in all treatments during fresh and storage period of 15 days at 5+-1 oC. The yogurt fortified with 1% *Moringa oleifera*concentration was overall most acceptable due to its better nutritional and physiochemical characteristics. Moreover, it is most acceptable among all other products by the sensory panel.

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SUMMARY

Moringa oleifera is is termed as life plant, miracle plant and multi-purpose plant for having several nutritional, pharmacological and industrial applications. It is used to make a novel fermented bio-product that is nutritionally rich and enhances the functionality of mango flavored yogurt. The effect of four different concentrations of moringa dried leaf powder are used during the production of mango flavored yogurt and analyzed for its physicochemical properties (pH, acidity, fat%, total soluble solids, moisture% ash%, fiber% and syneresis) and sensory characteristics. Results show that mango flavored yogurt fortified with 1% leaf powder of moringa oleifera has got highest score in majority of the sensory attributes over the storage period of 15 days at 5ºC. All treatments showed significantly (p [?] 0.05) higher results for acidity, total soluble solids, protein & syneresis as compared to control treatment during fresh and storage period. While, all treatments showed less pH and moisture content than control and fat was nearly same in all treatments during fresh and storage period of 15 days at 5+-1 oC. The yogurt fortified with 1% *Moringa oleifera*concentration was overall most acceptable due to its better nutritional and physiochemical characteristics. Moreover, it is most acceptable among all other products by the sensory panel.

Keywords: *Moringa oleifera,* inoculum, fortification, syneresis, organoleptic analysis, yogurt.

INTRODUCTION

Pakistan is second biggest country in terms of milk production renowned around the globe. The milk is majorly utilized to make yogurt, cheese, butter and other dairy products. Yogurt is gaining much importance for having numerous health benefits and functional properties that promotes better intestinal health and immune system. The protein present in milk creates the buffering action for active cultures (*Lactobacillus bulgaricus* & *Streptococcus thermophilus*) and proves to be the excellent medium for their activity during yogurt manufacturing. The concept of balanced diet, until the twentieth century, was considered to overcome the deficiency diseases associated with imbalance of nutrition obtained from consumption of different kinds of food [1]. But now in the era of developing and improving new scientific technologies nutrition is also being adapted with novel concept such as food fortification to undermine such cases [2]. This process involves addition of different vitamin, minerals, or ingredients to existing staple food to improve the micronutrient status of population. The foods that have increased demand & consumption level and are readily available, easily accessible and affordable among the population are subjected to fortification with compatible constituent. That could improve the health status of population rapidly at reasonable budget [3].

Moringa oleifera (drumstick tree, horse reddish tree, purifying tree, sohanjna, mulangay) belongs to family moringaceae is known to be the 21st century's "Super food" and famous medicinal herb. It is mostly found in diverse regions of tropical and sub-tropical areas around the globe specifically Sub-himalyan tract, India, Pakistan, Asia, Arabia and Africa. It is resistant to bacteria and fungi, tolerant to sandy condition and drought condition of soil. It is termed as life plant, miracle plant and multi-purpose plant owing to its miraculous nutritional, pharmacological and industrial applications [4]. It is highly nutritious & naturally enriched with double amount of protein than yogurt, it contains Vitamin C which is seven times more than as present in oranges, fifteen times more Potassium than banana, Calcium is seventeen times more than milk, 10 folds' additional vitamin A than carrots and 25 folds' additional iron than Spanish with respect to gram–in –gram comparison. It contains considerable amount of natural antioxidant including ascorbic acid, flavonoid, phenolic and carotenoid [5-6]. *Moringa oleifera* have natural biomolecules having particular vital response such as anti-inflammatory, inhibit oxidation, inhibit carcinogenic compounds, inhibit hypertension, anti-spasmodic, controls diabetic, cure ulcer, controls pyretic responses, anti-epileptic, anti-arthritis, diuretic, cholesterol lowering and hepatoprotective activities. It is also proposed for different disease and conditions including anemia, anxiety, blood impurities, bronchitis, chest congestion and cholera. It has revolutionized the cosmetic industry by contributing various health care products e.g. body and hair moisturizers and conditioner. Since Previous history, oil from moringa was utilized in the making of different kinds of ointments [7]. Still, the utilization of this miraculous plant in everyday life is very little specially in Pakistan. But in recent years, most research is going on in the utilization of *Moringa oleifera* leaves powder in distinct variety of food product i.e. sauce, drinks, spice, bread and milk-based product. But the major challenge while making the innovative food product is consumer acceptance and their preference because they are more cautious about taste and appearance. As moringa leaves gave bland and slight bitter taste to the product upon incorporation thus another aspect of this research was to overcome this challenge, mango flavor was utilized during production. Parallel to this also analyze either *Moringa oleifera* leaf powder will impart any positive impact on nutritional benefit, chemical properties, shelf life and storage stability of the yogurt.

MATERIAL AND METHODS

This research was conducted at Institute of Agricultural Sciences, University of the Punjab, Lahore Pakistan and PCSIR (Pakistan Council of Scientific & Industrial Research).

Procurement of raw materials

The raw material required for the research project including liquid whole milk and sugar were purchased from local market near central park housing society Lahore. Required strains (*Streptococcus thermophillus & lactobacillus bulgaricus)* used as starter culture, Mango flavor (Sun shine mango flavor) and Yellow Food Color (E101) were obtain from Food Technology laboratories & fungal culture bank of Institute of Agricultural Sciences, University of the Punjab.

Preparation of yogurt

The yogurt was prepared by using inoculum 3%, sugar 10%, mango flavor 1% and color 100 micrograms in all treatments expect the control sample. Only the concentration of Moringa dried leaves powder was differed and depicted in the following table 1.the steps involved in the production of yogurt is illustrated in fig 1.

Table 1: Concentration of *Moringa oleifera* leaves powder used during the manufacturing of mango flavored yogurt

Ingredients	$\mathbf{T_0}$	$\mathbf{T_1}$	$\mathbf{T_2}$	$\mathbf{T_3}$	$\mathbf{T_4}$
Moringa dried leaf powder (MDLP)	0.0%	0.5%	1%	1.5%	2%

Pasteurized cow milk (Chilled)

Heating at 45-50 ºC

Addition of sugar

Constant Stirring

Addition of starter/inoculum, moringa dried leaf powder (MDLP) at 41ºC

Addition color and flavor

Incubate at 37 ºC for 8-12 hours

Cool at 4-6 ºC

Cold store at 5 ºC

Fig 1: Flow Diagram for manufacturing of flavored yogurt fortified with*Moringa oleifera* leaves powder

Physico-Chemical Analysis

Milk analysis

The basic composition of milk used for the manufacturing of yogurt was analyzed and its moisture percentage, ash percentage, fat percentage, protein percentage, total soluble solids percentage and solid not fat (SNF) in percentage was determined by following standard procedures detailed by AOAC [8-9].

Moringa Oleifera leaf powder analysis

The *Moringa oleifera* leaf powder was analyzed for its chemical properties such as moisture, crude fiber, protein and ash in percentage was determined by following standard procedures detailed by AOAC [8-9].

Yogurt samples fortified with*Moringa oleifera*

In the yogurt samples fortified with different concentration of dried moringa leaf powder (control T_0, T_1, T_2, T_3 and T_4) the physical analysis such as acidity, pH and total soluble solids were determined by the methods described by AOAC [8-9]. While, other physical analysis termed syneresis for determination of yogurt consistency was done as described by Soukoulis et al. [10]. Similarly, chemical analysis including moisture, crude fat, total protein, total ash and fiber percentage were determined by the methods mentioned in AOAC [8-9]. All the treatments were analyzed for mentioned physicochemical properties at different storage condition for its shelf life study and storage stability at 10 days and 15 days at 5°C ±1.

Organoleptic analysis

For sensory evaluation expert panel of judges rated the product using numeric scoring system of 9-hedonic scale for the evaluation of appearance, taste, aroma, texture, flavor and overall acceptability as followed by Ahmed et al. [11].

Statistical analysis

Statistical Two-way Factorial analysis and Tukey's HSD pairwise comparison test was done by using SPSS Software (Statistic 8.1) probability of ($P<0.05$) was used to develop the statistical significance and to analyze the effect of varying concentration of moringa on treatments over the storage period of time.

RESULTS AND DISCUSSION

The chemical analysis included percentage moisture content, total solids percentage, ash percentage, protein percentage, solid not fat and fat of cow milk were determined as shown in Table 2. The obtained value of the milk fat was nearly similar to the findings of Khalid et al. [12] except the values of total solids, solid not fat and protein which is slightly lower as 11.29 % , 7.79 % and 2.97 % respectively. This might be as the result of different breed of cow and difference in the climatic conditions which directly affect the physiological condition of animal.

Table 2: Chemical analysis of raw material

Sample	**Moisture %**	**Total Solids %**	**Fat %**	**Solid not Fat %**	**Ash %**	**Protein %**	**C**
Cow milk	88.22	11.78	3.5	8.28	0.78	3.4	-
Moringa oleifera leaves	8.36±0.01	-	-	-	10.72±0.10	25.43±0.01	1

In table no. 2 the chemical composition of dried moringa leaves powder in which moisture content, ash, protein and crude fiber were analyzed. The results show that dried leaf powder contains high amount of fiber, protein and total mineral content. This specifies that dried*Moringa oleifera* leaf powder is one of the best sources of protein and minerals. Which is in accordance with the study of Hassan et al. [13] that mentioned moringa leaves powder contain great amount of protein 22.87 ± 0.05 and also rich source of mineral such as Calcium, Phosphorous, and potassium being 845, 108 and 414 respectively. Yaméogo et al. [14] suggested that moringa dried leaves contain moisture 11.9%, protein 10.6% and fiber 23.4% correspondingly. This variation among the value was might be due the different climatic condition and variety of moringa tree.

Physicochemical Analysis of Mango Flavored Yogurt Fortified with Moringa Oleifera Dried Leaf Powder

Table 3 revealed that as the quantity of *Moringa oleifera* . in. the yogurt treatments, enhances the mean values of total solids for all the treatments also increases over the storage period of 15 days. The highest total solid content was calculated for treatment T_4 (2% moringa oliefera leaf powder fortification) which was 22.057±0. 015, 23.35±0.47, 24.02± fresh, after 10 days and 15 days respectively and lowest was observed for control sample with the 0% moringa dried leaf fortification 13.5±0.1, 13.56±0.005, 9.97± fresh, after 10 days and 15 days respectively. The mean values for total solid contents of all the treatments increases progressively with the time of storage. El-Gammal et al. [15] also illustrate the same observation. After the statistical analysis the mean values of total solid content for the treatments showed significantly different (p [?] 0.05) results over the storage period up to 15 days. The mean value of total solid content showed significant increase (p [?] 0.05) for treatments over the .storage period of 15 days at . Above results are in line with study conducted by Hassan et al. [13]. Moisture content and total solid have inverse relation for any commodity i.e. total solid content increases with decrease in moisture content and vice versa. According to Table 3 the overall mean value for yogurt samples increase with time of storage and decrease with increase in the concentration of *Moringa oleifera* leaves powder. The highest moisture content value was observed for control sample T0 with 0 percent of moringa leaf powder supplementation 86.5+-0.1 for fresh sample and lowest was observed for treatment T_4 (2% moringa leaves powder fortification). Statistical analysis showed the significantly different (p [?] 0.05) results for all the treatments and control sample over the storage period for 15 days at 5degC and only slight decrease was observed in the mean values for moisture content for the control sample and all the treatments over the storage period. These results are in line with the findings of Bakr et al. [16].

The same table depicted that all the treatments nearly had similar mean values of fat content and no, as such difference was observed during the cold storage at 5+-1 C for over the period of 15 days. It was clearly shown that moringa leaf powder does not affect noticeable change to the fat content of the yogurt treatments. Quite minute change was observed in the mean values for moisture content for the control sample and all treatments over the storage period of 15 days at 5degC.All the treatments and control sample showed the significantly (p[?]0.05) different results for fat content over the storage period of 15 days. Which is in accordance with the study of El-Gammal et al. [15] and Shalini and Hn [17]. Whereas it is evident from Table 3 that as moringa leaf powder fortification percentage was increased in yogurt treatment the percentage of total protein content also increases. The highest protein content was observed in T_4 (2% moringa oliefera leaf powder) which was 4.68+-0.01. And lowest protein content was observed in treatment T_0 (0% moringa oleifera leaf powder and without flavor) 4.1133+-0.005. It is also evident from the table the all the treatments mean value of protein content gradually increases over the storage period of 15 days.

The results illustrate that the mean values of protein content for the all treatments increases significantly (p[?]0.05) over the storage period of 15 days at 5degC. That is in accordance with the observation of Madukwe et al. [18]. Shokery et al. [19] found in his research, that in buttermilk supplemented with moringa leaves and moringa pods powder showed the same results.

Table 3: Phyisco-chemical composition of mango flavored yogurt fortified with 0 %, 0.5%,1%, 1.5% and 2% Moringa Oleifera dried leaf powder, fresh and during cold storage of 5+-1degC.

Yogurt Treat-ments	**Storage Period (Days)**	**TSC (g/100g) ±S. D**	**Moisture% (g/100g) ± S.D**	**F.C ± S.D (g/100g)**	**T.P± S.D (g/100g)**	**pH ± S.D**	**Acidity± S.D (g/100g)**	**Ash% (g/100**
	Zero	13.5±0.1	86.5±0.1	3.5133± 0.01	4.1133±0.005	4.44±0.01	0.871±0.001	1.21±0.
Control	10	13.56±0.005	86.7±0.1	3.4867± 0.005	4.12±0.01	4.19± 0.01	0.92733±0.005	2.0733±
	15	9.97±6.936	87.647±1.146	3.5067±0.005	4.15±0.01	4.036±0.015	1.013±0.001	2.95 ± 0.01
	Zero	17.803±0.005	82.167±0.05	3.4867±0.005	4.13±0.01	4.2667±0.015	1.081±0.001	1.61±0.
T_1	10	19.077±0.02	82.3±0.1	3.5003±0.005	4.17±0.01	4.0533±0.015	1.131±0.001	2.4633±
	15	19.22±0.02	82.57±0.01	3.4733±0.005	4.21±0.01	3.87±0.01	1.21633±0.005	3.4633±
	Zero	18.767±0.05	81.027±0.005	3.51±0.01	4.32±0.01	4.26±0.02	1.106±0.001	2.51±0.
T_2	10	20.14±0.01	81.223±0.005	3.4867±0.005	4.36±0.01	4.03±0 .01	1.15633±0.005	3.4567±
	15	20.24±0.01	81.39±0.01	3.4867±0.005	4.21±0.01	3.85±0.01	1.233±0.001	3.85±0.

Yogurt Treatments	Storage Period (Days)	TSC (g/100g) ±S. D	Moisture% (g/100g) ± S.D	F.C ± S.D (g/100g)	T.P± S.D (g/100g)	pH ± S.D	Acidity± S.D (g/100g)	Ash% (g/100
	Zero	21.013±0.01	79.167±0.05	3.4733±0.005	4.52±0.01	4.22333±0.015	1.1263±0.005	3.41±0.
T_3	10	22.32±0.01	79.2±0.1	3.4767±0.005	4.55±0.01	3.99±0.01	1.175±0.001	4.48±0.
	15	22.42±0.01	79.27±0.01	3.5003±0.005	4.58±0.01	3.8133±0.005	1.24±0.001	4.75±0.
	Zero	22.057±0.015	77.3±0.1	3.4767±0.005	4.68±0.01	4.17±0.01	1.137±0.001	4.31±0.
T_4	10	23.35±0.47	77.5±0.1	3.51±0.0	4.72±0.01	3.94±0.01	1.186±0.001	5.4133
	15	24.02±0.02	77.57±0.01	3.4733±0.005	4.75±0.01	3.74±0.01	1.26267±0.005	5.66±0.

*The same column (for storage periods) is significantly different ($p<0.05$), each value is a mean of 3 replicates, TSC: Total solids and TP: Total protein F.C: Fat Content

It is evident from the table 3 that highest mean value for pH of the sample were observed for control sample during fresh condition i.e. 4.44±0.01, that gradually decrease over the storage period of 10 days i.e. 4.19± 0.01 and further decreased at 15$^{\text{th}}$ day i.e. 4.036±0.015. The lowest mean value for pH showed by T_4(2% moringa leaves powder fortification) which was 4.17±0.01, 3.94±0.01 and 3.74±0.01 for fresh, 10$^{\text{th}}$ day and 15$^{\text{th}}$ day of storage at 5° C. The overall trend depicted the decrease in pH values for all the treatments over the storage period. Reason being, the conversion of lactose (milk sugar) into lactic acid with increasing acidity will lower the pH. The inferences from the result showed that by supplementation of moringa dry leaves powder in yogurt. pH of yogurt in treatments will decreased. Because moringa oleifera leaves powder will stimulate the growth rate of starter culture. The results for pH showed significant (p [?] 0.05) decrease for all the treatments over the storage period up to 15 days at 5+-1 degC that is similar to the study of El-Gammal et al. [15] showed that significant reduction in pH was observed in the yogurt supplemented with aqueous extract of moringa leaves than to the control samples.

The result illustrate in same table are contrary to the mean vales of pH for all the treatments that is, by increasing the percentage of moringa oleifera leaf powder in the yogurt samples the percentage of acidity also increases and over the period of 15 days. The results revealed that T_4 showed highest titrable acidity values than other treatments i.e. 1.137+-0.001, 1.186+-0.001 and 1.26267+-0.005 at fresh day, 10$^{\text{th}}$ day and 15$^{\text{th}}$ day of storage. That decreases with decrease in concentration of Moringa oleifera leaf powder. Thus lowest was observed for control sample i.e. 0.871+-0.001, 0.92733+-0.005 and 1.013+-0.001 at fresh day, 10$^{\text{th}}$ day and 15$^{\text{th}}$ day of storage. Due to bacterial activity lactose (milk sugar) is converted into lactic acid and causing the decline of pH and rise of acidity [20]. The mean for acidity values showed significant increase (p [?] 0.05) for all the treatments over the storage period of 15 days at 5degC. Results of titrable acidity were also same as the observation of Ahmed et al. [11]. Ash content determines the total mineral content in the sample. Same table 3 depicted observed mean values of ash content for yogurt samples fortified with different quantity of moringa leaves powder, with enhanced quantity of moringa leaves powder ash content of the treatments will also increase. Therefore, the highest mean values were observed for $T_4$4.31+-0.01, 5.4133+-0.015 and 5.66+-0.01 over the storage period of 15 days. Lowest mean value for ash content was observed for control sample i.e. 1.21+-0.01, 2.0733+-0.06 and 2.95 +- 0.01 over the storage period. The trend over the storage period of 15 days was observed and results illustrate that ash content increased for all the treatments. The mean values for ash content showed significantly slight increase (p [?] 0.05) for all treatments over the storage period of 15 days at 5degC. The results are in agreement with the observation of Dixit et al. [21] during development of Lassi using whey and moringa powder.

It is obvious from the fig 2 that wheying off slightly decreased as quantity of moringa leaves powder increases. Highest syneresis was observed in treatment T_4 (2% moringa oleifera leaf powder and without flavor) 3.0733 +-0.06 for fresh (day 0).While the decreasing trend was seen in other treatments evident in fig 2 for treatment T0 yogurt fortified with zero fortification of moringa powder, 0.5% moringa leaf powder T_1, 1% moringa leaf powder T_2, and 1.5% moringa leaf powder T_3, which was 1.15+-0.01, 2.8+-0.01, 2.83+-0.01 and 2.87+-0.01 respectively at day 0. At the 10$^{\text{th}}$ day of storage the syneresis will gradually increase and maximum was observed for T_4 (2% moringa oleifera leaf powder and without flavor) 3.363 +-0.005 which further increased at 15th day reached to 3.89+-0.01. And lowest value was observed for control sample with zero fortification of moringa leaf powder which was 1.87+-0.01 and 2.49+-0.01 at 10th day & 15th day of storage at 5degC. He statistical analysis illustrates that syneresis value for the treatments showed significantly different (p [?] 0.05) results over the storage period up to 15 days at 5degC. It was also observed by Salem et al. [22] that over the storage time period of 15 days syneresis increases gradually. [CHART]

Fig.2: Graphical representation of effect on syneresis content of flavored yogurt samples fortified with moringa oleifera leaf powder

Sensory evaluation

0 day of storage period (fresh samples)

The scores for the sensory properties (appearance, aroma, body & texture, taste, flavor, and overall acceptability) were illustrated in fig 3 by radar chart. The highest scores were observed for appearance, taste, body & texture, overall acceptability and flavor for treatment T_2 with 1% of fortification of *Moringa oleifera*dried leaf powder having mean values 7.8+- 0.01, 7.8 +- 0.01, 8.016+- 0.01, 8.11+- 0.01, 7.8+- 0.01 respectively and highest score for aroma was observed for T_1 fortified with 0.5% moringa dried leaf powder which was 7.4+- 0.01 in fresh mango flavored fortified sample. The lowest score for all the sensory characteristics except body and texture was observed for T_4 treatment having fortification of 2% moringa dried leaf powder, which was appearance, aroma taste, overall acceptability and flavor 6.3+- 0.01, 6.6+- 0.01, 6.2+- 0.01, 6.4 +- 0.01 and 6.2 +- 0.01 and treatment T_3 (1.5 % moringa dried leaf powder fortification) showed the lowest score for body & texture properties with the score of 6.61+- 0.01.

10th day of storage period

The sensory properties (appearance, aroma, body & texture, taste, flavor, and overall acceptability) were analyzed for its sensory characteristics and illustrated in fig 3 in the form of radar chart. The highest scores were observed for appearance, aroma, taste, body & texture, overall acceptability and flavor for treatment T_2 with 1% of fortification of *Moringa oleifera*dried leaf powder having mean values 6.8+- 0.01, 7.6 +- 0.01, 7.4+- 0.01, 7.6 +- 0.01, 7.633+- 0.01 and 7.60 respectively. The lowest score for all the sensory characteristics except body and texture was observed for T_4 treatment having fortification of 2% moringa dried leaf powder, which was appearance, aroma taste, body & texture overall acceptability and flavor 6.1+- 0.01, 6.2+- 0.01, 6.03+- 0.01, 5.4 +- 0.01, 6.203 +- 0.01 and 5.4.

15th day of storage period

The sensory properties (appearance, aroma, body & texture, taste, flavor, and overall acceptability) were observed at 15th days of storage for its sensory characteristics and illustrated in fig 3 in the form of radar chart. The highest scores were observed for treatment T_2 with 1% of fortification of *Moringa oleifera* dried leaf powder appearance, aroma, taste, body & texture, overall acceptability and flavor having mean values 6.4+- 0.01, 6.6 +- 0.01, 6.6+- 0.01, 6.63 +- 0.01, 6.603+- 0.01 and 6.80 +- 0.01 respectively. The lowest score for all the sensory characteristics except body and texture was observed for T4 treatment having fortification of 2% moringa dried leaf powder, which was appearance, aroma taste, body & texture overall acceptability and flavor 6.2+- 0.01, 5.1+- 0.01, 4.8+- 0.01, 5.2 +- 0.01, 5.2 +- 0.01 and 5.03+- 0.01. T_2 treatment proves to be the best combination of flavor and moringa fortification (1% moringa dried leaf powder) at 0 day, 10th day and even 15th day of storage. Which was not in accordance with the observation of Hassan et al. [23] that control sample got the highest score than other treatments although the concentration used for the sample was nearly same as used for this research which was 1% moringa powder, 1.5 % moringa powder and 2% moringa powder supplemented in yogurt treatments. The possible reason could be the difference in the people tastes and eating habits or the additional mango flavor mask the bitter taste, aroma and overall appearance in the yogurt sample. In fact, it enhances the overall acceptability. The result for body & texture were similar to the observation of El-Gammal et al. [15]. He explained that, by using the extract (aqueous) of moringa in the yogurt fortification it improves the hardness, gumminess, cohesiveness, springiness, indeed overall body & texture of the product. Thus, scores were significantly higher for the treatments than control.

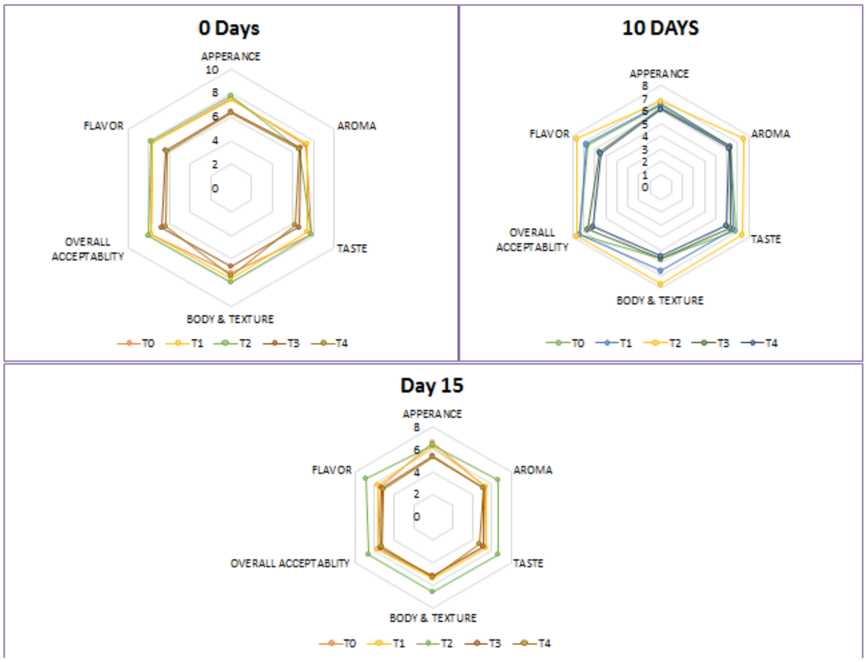

Fig.3: The effect of addition of moringa leaves powder in different concentration on the sensory characteristics of fresh (day 0) yogurt, 10 days & 15 days of storage at 5±1ºC

CONCLUSION

1% *Moringa oleifera* dried leaves powder with the addition of mango flavor and color was the best combination for the production of yogurt. This ratio will enhance and positively affect the nutritional profile, physicochemical properties and sensory characteristics, of resultant yogurt. The yogurt fortified with 1% *Moringa oleifera*concentration was overall most acceptable.

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