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Qualitative evaluation of nutritious chocolate by using *Moringa Oleifera* leaves powder

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Abstract

Moringa oleifera is universally referred to as the miracle plant or the tree of life. They contain substantial amounts of vitamins, minerals and phytonutrients. *Moringa oleifera* leaves necessitate the need for this research to explore its utilization. The research was carried out to increase the nutritious value of chocolate by incorporation of *Moringa oleifera* leaves Powder. The Chocolate was prepared by using different concentration (0%, 5%, 10%, 15% and 20%) of *Moringa oleifera* leaves powder in comparison to normal recipe. The chocolate prepared was subjected to physicochemical and sensory evaluation. The results indicated that the proximate analysis of supplemented chocolate, protein, ash and crude fiber contents of produced chocolate increased with increasing the incorporation level of the *Moringa oleifera* leaves powder. According to the sensory evaluation, 10% and 15% supplemented chocolate were rewarded best for human consumption.

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Introduction

Chocolate was originated in Mexico and cocoa tree were cultivated by the Aztec, Inca and Maya. In most of the developed countries including North America and Europe, chocolate has turn out to be the most popular confection. Cocoa is now mainly grown in Sri Lanka, West Africa and Indonesia (Dillinger *et al.*, 2000). Cocoa tree has a scientific name, *Theobrama cacao* where 'theo' means 'God' and 'broma' means 'drink' given by an association. This property was given by the Swedish naturlist Carl von Linné (Kris-Etherton, Mustad, & Derr, 1993).

Theobroma cacao is the plant from which cocoa beans are collected. In Nigeria, dried cocoa beans are mainly exported to foreign exchange earners and a small amount of these beans are used as a source of cocoa butter, cocoa powder and chocolate products (Adeyeye, Akinyeye, Ogunlade, Olaofe, & Boluwade, 2010). Cocoa pods are harvested from cocoa tree, beans are removed and then they are fermented. Chocolate liquor is made by grinding the cocoa beans and is basis of all the chocolate products. The cocoa powder is prepared by eliminating the cocoa butter from liquor. Dark chocolate (also called bittersweet chocolate) contains 15% liquor and may contain upto 60% remainders that are sugar, cocoa butter and additional additives. Milk chocolate containing chocolate liquor (10-12%) is consumed in United States. (Apgar, Tarka, & Stanley, 1998).

The cocoa powder of high quality should be uniform in colour, free flow, good microbial quality and easy to use (Vu, Galet, Fages, & Oulahna, 2003). The nutritional value of the cocoa product depends primarily on the constituents of the cacao powder, depending on the amount of phytochemicals, proteins, fats, carbohydrates and minerals (Belscak, Komes, Horzic, Ganic, & Damir, 2009; Adeyeye, Akinyeye, Ogunlade, Olaofe, & Boluwade, 2010; Lettieri-Barbato *et al.*, 2012). Cocoa beans and their derivatives also provide abundant sources of phytonutrients, especially proanthocyanidins and catechins (Lecumberri *et al.*, 2007). Beverages were also being prepared with cocoa powder and other ingredients i.e. sugar and milk while cocoa butter is used for the production of chocolate. Most of the people desired chocolate products because of their attractive appearance and flavour (Othman, Ismail, Ghani, & Adenan, 2007; Pimentel, Nitzke, Klipel, & de Jong, 2010).

The main types of chocolate are white, milk and dark (Afoakwa, Paterson, & Fowler, 2007). Milk chocolate beverages or solid chocolate bars contain different amount of cocoa solids, cocoa butter, cocoa liquor, milk and sugar and other component is cocoa powder that is also used as a component in chocolate baked products i.e. chocolate cake, cookies, etc. Due to its flavour and textural characteristics, chocolate is usually considered a caloric and fat-rich food but lacked in essential nutrients (Adamson *et al.*, 1999; Vinson, Proch, & Zubik, 1999). Cocoa butter is the main fat of the dark chocolatethat contains approximately 25% saturated palmitic acid, 33% saturated stearic acid and 33% monounsaturated oleic acid (Kris-Etherton, Mustad, & Derr, 1993). Milk chocolate contains much lesser flavonoids than dark chocolate (Vinson, Proch, & Zubik, 1999). The nitrogen-containing compounds of cocoa consist of both proteins, the caffeine, the bromine and methyl xanthine. They are diuretics, CNS stimulants and relaxants. The minerals present in cocoa mass are magnesium, zinc, iron, copper, phosphorus and potassium (Ashton & Ashton, 2003).

Chocolate supplemented with calcium resulted in greater fatty acid (saturated) and fecal fat than chocolate without supplementation of calcium (Murata *et al.*, 1998). Chocolate enriched with live lactobacilli and the development of chocolate manufacturing improvements for the survival of lactic acid bacteria that would help to enhance the beneficial effects of this supplemented chocolate on the health of the human being (Homayouni, Roudbaneh, & Hosseyni, 2014).

Moringa oleifera (also known as the miracle plant) commonly found in Pakistan, Afghanistan, Bangladesh and India. Moringa is used in nutrition and also medicines (Fahey, 2005). Moringa can survive in poor soil, can grow easily in humid tropical areas and is also less affected in drought (Anwar, Sajid, Muhammad, & Anwarul, 2007).It is reported that moringa which contains many trace elements, is a rich source of protein, minerals, carotene and vitamin C and is also a source of antioxidants i.e. carotenoids, phenols, ascorbic acid and flavonoids (Chumark *et al.*, 2008). Moringa is nutritious due to the presence of various phytochemicals in seeds, pods and leaves. It is also reported that moringa has 7 times vitamin C than oranges, calcium is 17 times more than milk, vitamin A is 10 times more than carrots, 9 times protein is more than yoghurt, 25 times iron is more than spinach and 15 times potassium is more than bananas (Rockwood, Anderson, & Casamatta, 2013).

Moringa oleifera leaves can be eaten either it is fresh or cooked and can be stored in dry powder for several months without any nutritional loss (Fahey, 2005). Moringa leaves have also been used for infants and children that were under malnutrition (Anwar, Sajid, Muhammad, & Anwarul, 2007). Moringa leaves have been reported to contain significant amounts of iron, copper, manganese, potassium, calcium, magnesium, proteins and total phenols. Moringa leaves also contain different quantities of vitamin E, vitamin C and vitamin A (Hekmat, Morgan, Soltani, & Gough, 2015). Moringa leaves also contain phytonutrients i.e. ascorbic acid, tocopherols and carotenoids (Saini, Prashanth, Shetty, & Giridhar, 2014; Saini, Shetty, Prakash, & Giridhar, 2014). These nutrients are combined with balanced diet to absorb the free radicals and also have immunosuppressive property (DanMalam, Abubakar, & Katsayal, 2001). In addition to a small number of phytochemicals i.e. anthocyanin, saponins, tannins etc. dried moringa leaves also contain fat (2.74 g/100g), water (4.09 g/100g), fibers (9.31 g/100g), proteins (18.92 g/100g) and carbohydrates (57.01 g/100g) (Nweze & Nwafor, 2014).

Quality evaluation; overall composition of amino acids, mineral contents (essential) and chemical composition of moringa leaves and determination of the quality of chocolate by mixing the protein with moringa in different concentrations (Abou-Zaid & Nadir, 2014). Different parts of *Moringa oleifera* is used in many foods i.e. yoghurt (Hekmat, Morgan, Soltani, & Gough, 2015), cake (Kolawole, Balogun, Opaleke, & Amali, 2013), bread (Chinma, Abu, & Akoma, 2014),biscuits (Alam, Alam, Hakim, Huq, & Moktadir, 2014), amala, a dough made from banana and yam flour (Karim, Kayode, Oyeyinka, & Oyeyinka, 2013; Karim, Kayode, Oyeyinka, & Oyeyinka, 2015) and making soups (Babayeju *et al.*, 2014).

Today, customers are more conscious about the food containing nutritional value and referring the chocolate and cocoa powder as the good sources of many phytochemicals and essential nutrients that can promote a diet healthy (Lecumberri *et al.*, 2007; Ieggli, Bohrer, Nascimento, & Carvalho, 2011). Keeping in mind the above-mentioned facts and figures, the present study was designed to achieve the following objectives;

First, to prepare a healthy nutritious chocolate by using different blends of *Moringa oleifera* leave powder. Second, to evaluate physicochemical and sensory attributes of prepared chocolate.

Materials and methods

The present research was conduct in the evaluation laboratory of Food Technology department of PMAS-Arid Agriculture University Rawalpindi. The purpose of present research is to enhance the nutritional properties of chocolate and depicted the best concentration of fortification level for the acceptance by the consumer demand and nutritional benefits. Experiments were followed the Completely Randomized Designed with four levels of Moringa Leaf Powder concentrations with three replications. Fresh Moringa leaves were taken from university while cocoa powder was managed from the local market of Rawalpindi for the development of moringa supplemented chocolate.

The Moringa leaves were dried in hot air oven at 45-50 °C and grinded to convert into a powder which were then placed in polyethylene pouches and stored at room temperature for more use. *Moringa oleifera* leaves powder were incorporated in cocoa powder at different levels to prepared blends that were used in making a supplemented chocolate. *Moringa oleifera* leaves powder were mixed with cocoa powder at different levels of 0, 5, 10, 15 and 20% to produce a supplemented chocolate.T0 = Control, T1 = 5% Moringa Powder, T2 = 10% Moringa Powder, T3 = 15% Moringa Powder, T4 = 20% Moringa Powder. *Moringa oleifera* leaves powder was used in different concentration of 0, 5, 10, 15 and 20% to produce a supplemented chocolate. The chocolate was prepared by the procedure used in (Joel, Pius, Deborah, & Chris, 2013). Once prepared, the supplemented chocolate was cooled to 7 °C, wrapped in aluminium foil and stored at 5 °C in freezer for further analysis.

Cocoa powder and fat were mixed with other ingredients like milk and sugar. The cocoa powder and fat of all samples were conched for 45 mins at 80 °C, with the help of stone-mill for velvet smoothness. Each sample was tempered with stirring and cooling to 45°C and poured into a mold for proper shaping and hardening. Aluminium foil was used to wrapped the supplemented chocolate and stored at 5 °C in freezer for different analysis.

Proximate analysis of supplemented chocolate

The moisture constant of supplemented chocolate was measured by drying 5g of sample in triplicate in an oven at 105±2 till the constant weight achieved according to AACC (2000) with Method No. 44-19.The moisture content was calculated by the formula as given below:

$$\text{Moisture (\%)} = \frac{\text{Weight of sample (g)} - \text{Weight of dried sample (g)}}{\text{Weight of sample (g)}} \text{X100}$$

The ash content of supplemented chocolate was determined by the method described in AACC (2000) with Method No. 08-01. 5g samples of supplemented chocolate were dried in triplicate in hot air oven and ignited then in muffle furnace at 550˚C for 5-6 hrs till the color of ash became greyish. The ash content of supplemented chocolate was measured by the formula given as follow:

$$\text{Ash content (\%)} = \frac{\text{Weight of sample after ashing}}{\text{Weight of sample}} \text{X100}$$

The nitrogen contents of the supplemented chocolate were determined with the help of Auto-Kjeldhal apparatus while the protein contents were measured by multiplying the factor of 6.25 with nitrogen contents as described in AACC (2000) with Method No. 46-10.Crude protein was calculated using following formula:

$$\text{Nitrogen \%} = \frac{\text{Vol. of 0.1 NH2SO4 used} \times 0.0014 \times 250}{\text{Weight of sample} \times \text{Vol. of diluted sample used}} \times 100$$

The Crude fat content of the supplemented chocolate samples were measured by the method described in AACC (2000) with Method No. 30-10 by using a solvent such as petroleum ether in Soxhlet's apparatus. The fat content was calculated by the formula as follow:

$$\text{Crude Fat (\%)} = \frac{\text{(Weight of flask + fat)} - \text{(Weight of empty flask)}}{\text{Weight of sample}} \text{X 100}$$

The crude fiber content of the supplemented chocolate was determined according to the method described in AACC (2000) with Method No.32-10.01. The sample should be de-fated, the fat free sample was treated with 1.25% H_2SO_4 and 1.25% NaOH solutions. The obtained residue was filtered through filtration unit, washed with hot water and ignited for overnight in muffle furnace. Percentage fiber of the supplemented chocolate was measured by the following formula:

$$\text{Crude fiber (\%)} = \frac{\text{W1} - \text{W2}}{\text{Weight of sample}} \text{X 100}$$

The carbohydrate content of the supplemented chocolate was measured by subtracting the total percentage of moisture, ash, protein, fat and fiber from 100 (Shimelis &Rakshit, 2005). The carbohydrate content was calculated by the formula given as below:

Carbohydrate% = 100-(fat+ Crude fiber+ Crude protein+ Ash + moisture).

Sensory Evaluation of Supplemented Chocolate

The sensory evaluation of the supplemented chocolate was evaluated by a trained sensory panel according to the procedure of (Fang *et al.,* 1971; Iwe, 2010),the sensory characteristics were obtained for taste, color, taste, texture and overall acceptance of supplemented chocolate.

Statistical analysis

The final data was anlayzed statistically for ANOVA (analysis of variance) and difference in values of means according to method described in (Steel and Dickey, 1997).

Results and discussion

Moisture Content

Mean values for moisture content in chocolate is presented in Fig. 1.

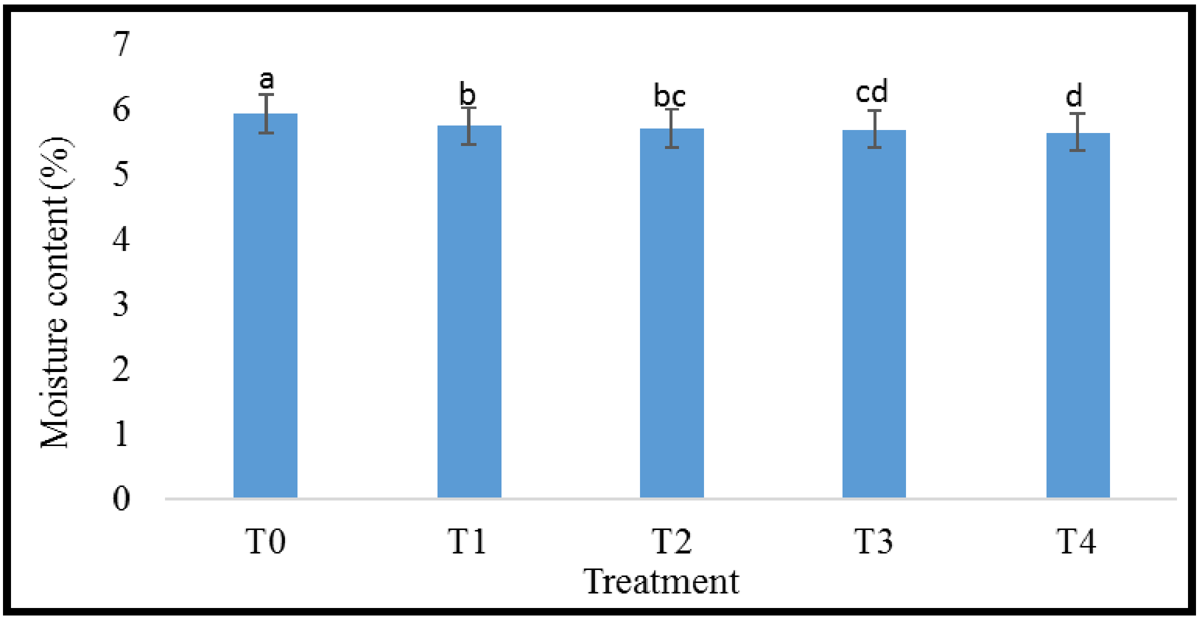

Fig. 1. Mean values of moisture content (%) in supplemented chocolate.

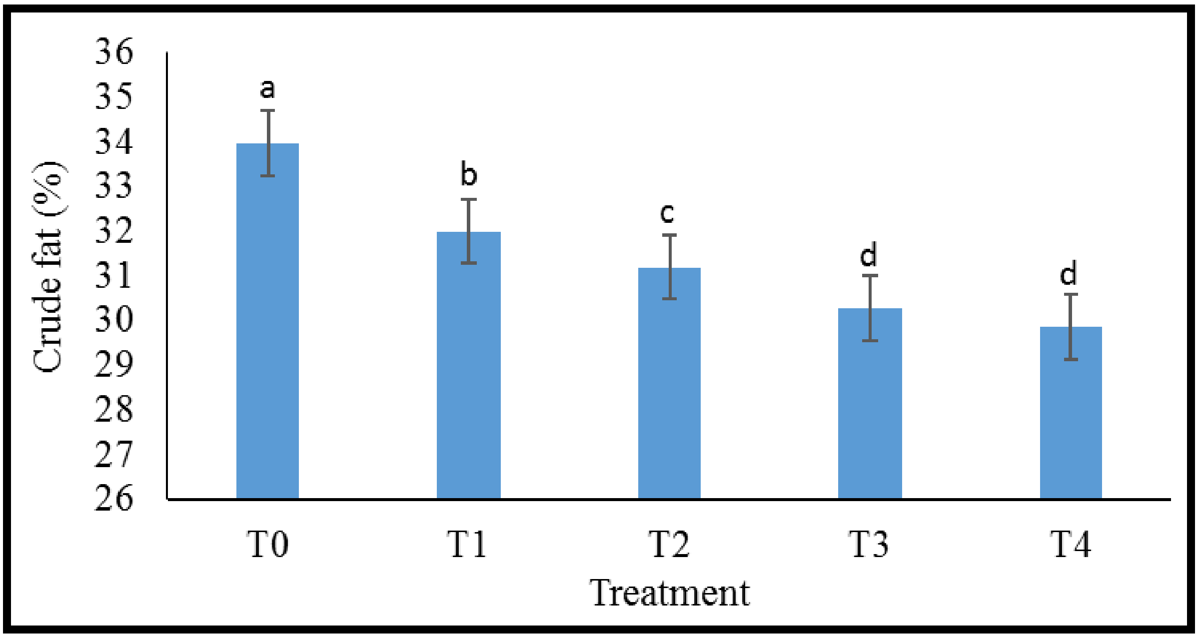

Fig. 2. Mean values of crude fat (%) in supplemented chocolate.

Result shown that there is significance difference ($p > 0.05$) among all the level of fortification of moringa leaves powder. Moisture content was decreased by moringa leaves powder. Minimum value for moisture content in chocolate (5.93%) was found in 0% moringa leaves powder fortification level. Similarly, maximum values (5.69% and 5.64%) was found in 15% and 20 % moringa leaves powder fortification level respectively, moderate moisture content was found (5.74%) and (5.71%) in 5% and 10% moringa leaves powder fortification level. These results contradicts with the findings of Abou-Zaid and Nadir, (2014) who reported a non-significant effect of moringa leaf powder on moisture content of chocolate.

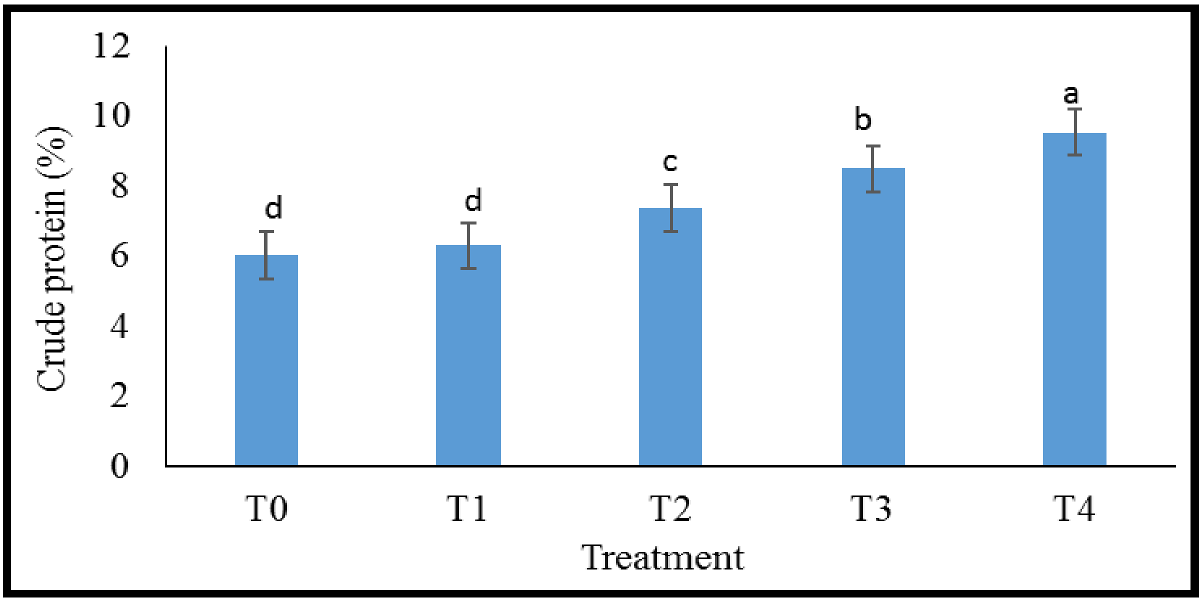

Fig. 3. Mean values of crude protein (%) in supplemented chocolate.

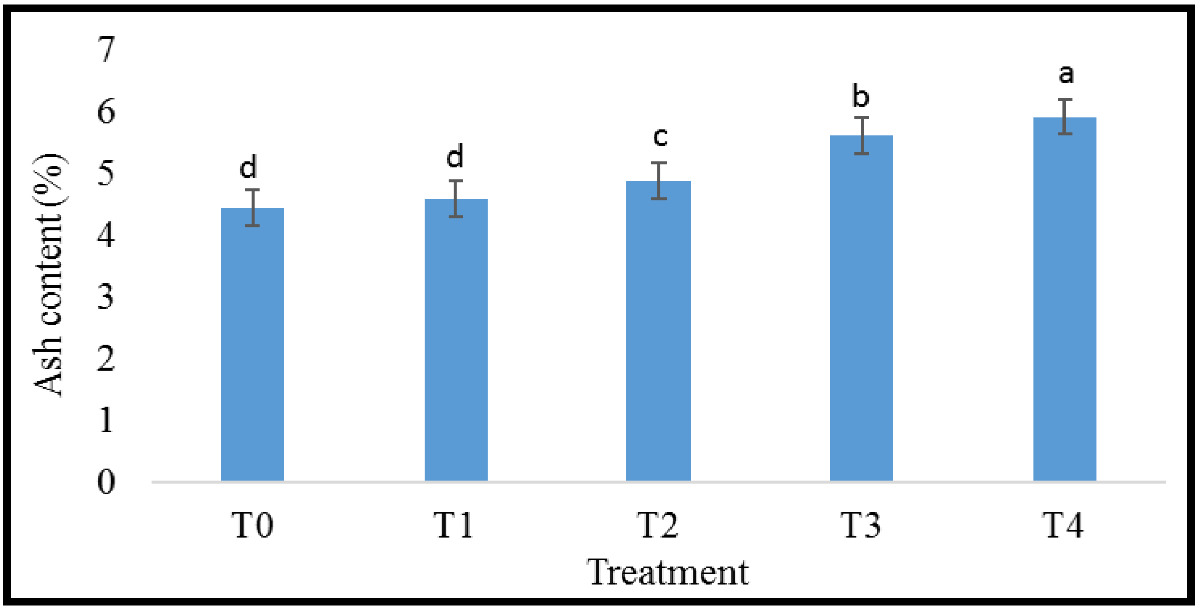

Fig. 4. Mean values of ash content (%) in supplemented chocolate.

Crude Fat

In Fig. 2, mean values of crude fat (%) in supplemented chocolate showed the significance difference ($p > 0.05$) among all the level of fortification of moringa leaves powder. Minimum value for fat content in cookies (29.85) was found in

20 % moringa leaves powder fortification level. However, maximum value (33.97) was found in 0 % moringa leaves powder fortification level respectively, moderate fat content was found (31.20)and (30.28) in 10 % and 15 % moringa leaves powder fortification level. There is non-significant difference found in the chocolate supplemented with 15% and 20 % moringa leaves powder. Crude fat was decreased by moringa leaves powder. These results were found in accordance with the results of Ijarotimi *et al.*, (2013)who indicated a decrease in fat content was decreased with the supplementation of moringa leaves powder in chocolate.

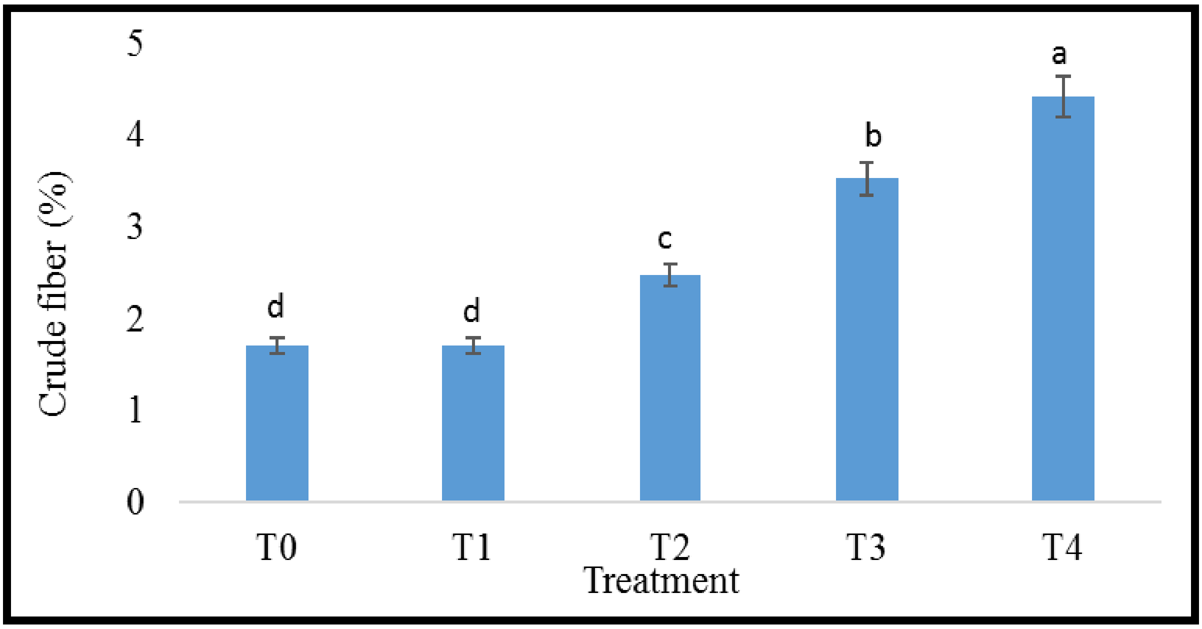

Fig. 5. Mean values of Crude fiber (%) in supplemented chocolate.

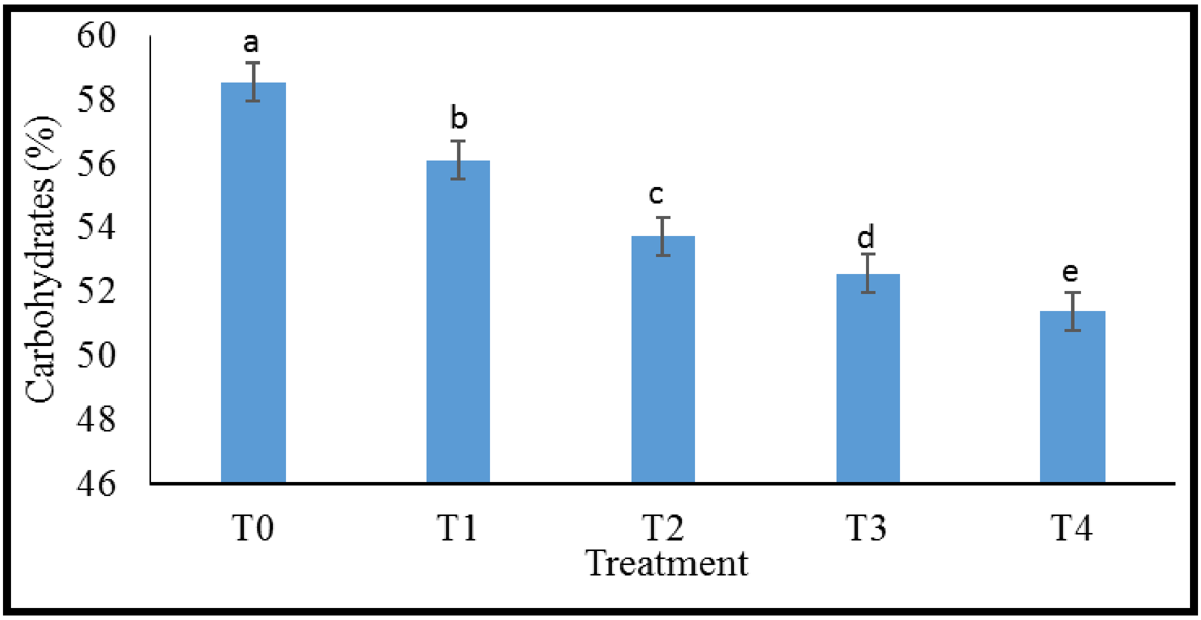

Fig. 6. Mean values of carbohydrates (%) in supplemented chocolate.

Crude Protein

Protein is the major component of chocolate that is necessary for the growth and development of human being. Crude protein content in chocolate shown the significance difference ($p > 0.05$) among all the level of fortification of moringa leaves powder. Minimum value for protein content in chocolate (6.03) was found in 0 % moringa leaves powder fortification level. Similarly, maximum value (9.54) was found in 20 % moringa leaves powder fortification level respectively, moderate protein content was found (7.38) and (8.55) in 10 % and 15 % moringa leaves powder fortification level. There is non-significant difference found in the chocolate supplemented with 0 % and 5 % moringa leaves powder. It was reported that the Moringa leaves were a good potential source of supplementary protein vegetable meals (Aletor and Adetogun 1995), and a good potential source of supplementary protein in animal diets (Moyo *et al.*,2011). The amount in protein content found increased with the supplementation of moringa leaves powder in chocolate.

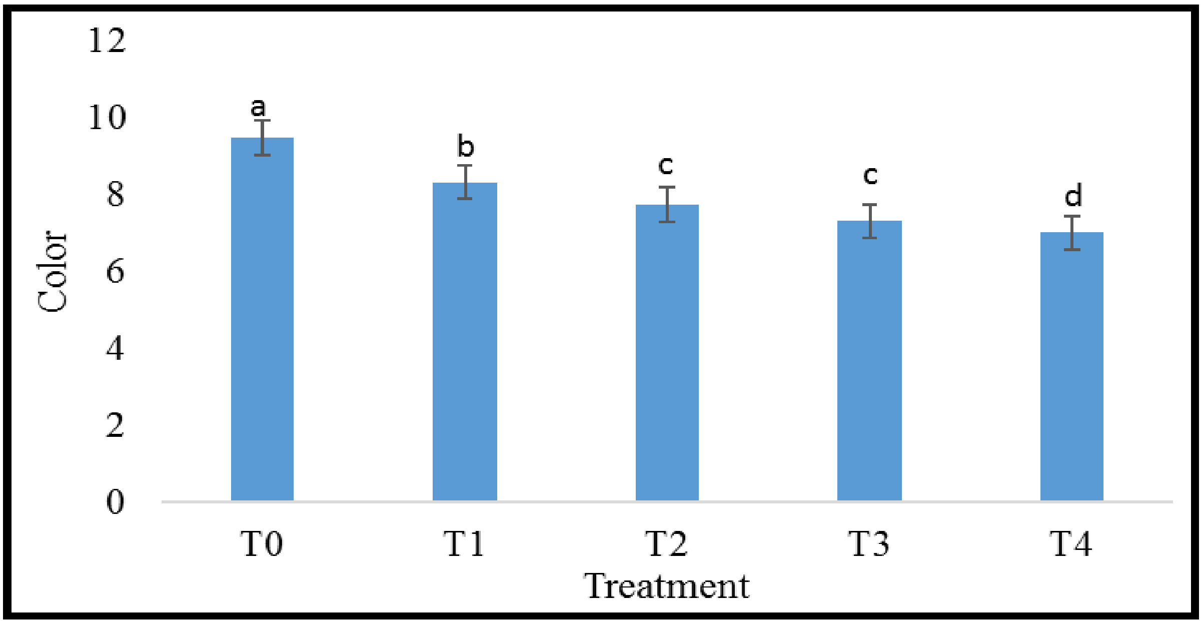

Fig. 7. Mean values of color (%) in supplemented chocolate.

Ash Content

Ash content was present in chocolate shown the significance difference ($p > 0.05$) among all the level of fortification of moringa leaves powder. Mean values with standard deviation for ash content shown in Fig. 4.

Minimum value for ash content in cookies (4.45) was found in 0 % moringa leaves powder fortification level. Similarly, maximum value (5.92) was found in 20 % moringa powder fortification level respectively, moderate ash content was found (4.89) and (5.61) in 10 % and 15 % moringa leaves powder fortification level.

There is non-significant difference found in the chocolate supplemented with 0 % and 5 % moringa leaves powder. Ash content was increased due to the appreciably higher ash contents of the moringa leaves powder. These results were found in accordance with the results of (Ijarotimi *et al,* 2013). Ash content was increased with the supplementation of moringa leaves powder in chocolate.

Crude Fiber

Crude fiber content in chocolate showed the significance difference ($p > 0.05$) among all the level of fortification of moringa leaves powder. Mean values with standard deviation for crude fiber content shown in Fig.5. Minimum value for fiber content in chocolate (1.71) was found in 0 % moringa leaves powder fortification level. Similarly, maximum value (4.43) was found in 20 % moringa leaves powder fortification level respectively, moderate fiber content was found (2.48) and (3.53) in 10 % and 15 % moringa leaves powder fortification level. There is non-significant difference found in the chocolate supplemented with 0 % and 5 % moringa leaves powder. These results were found in accordance with the results of (Ijarotimi, Fagbemi, & Osundahunsi, 2013).Fiber content was increased with the supplementation of moringa leaves powder in chocolate, this might due to incorporation of high fiber contents found in moringa leaves powder to the cocoa powder.

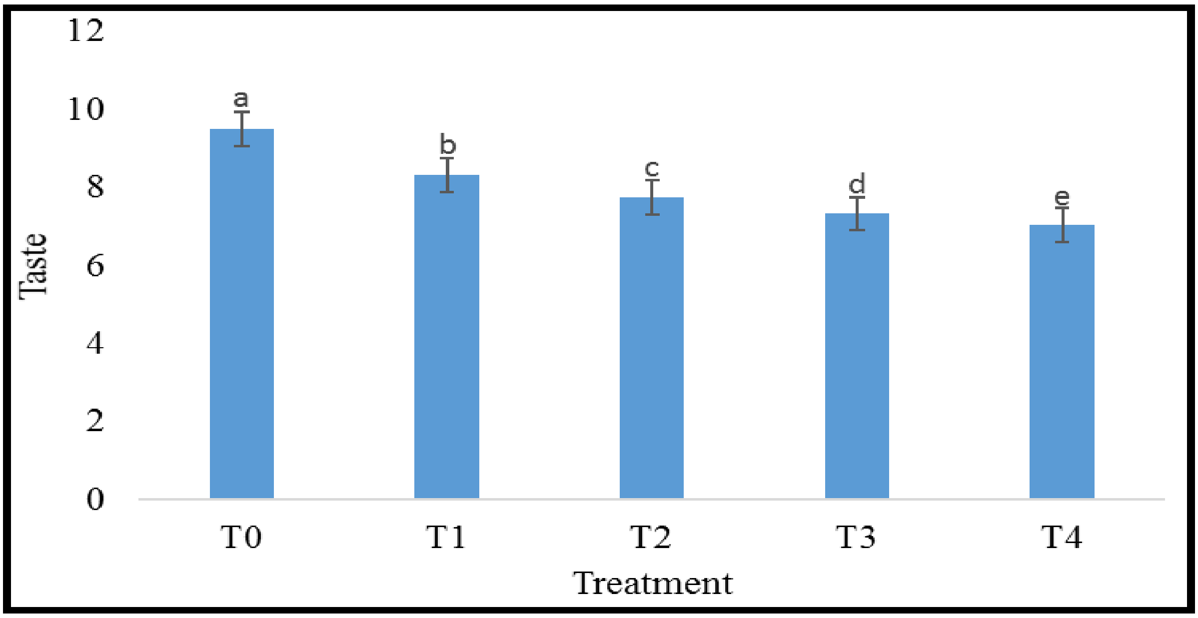

Fig. 8. Mean values of taste (%) in supplemented chocolate.

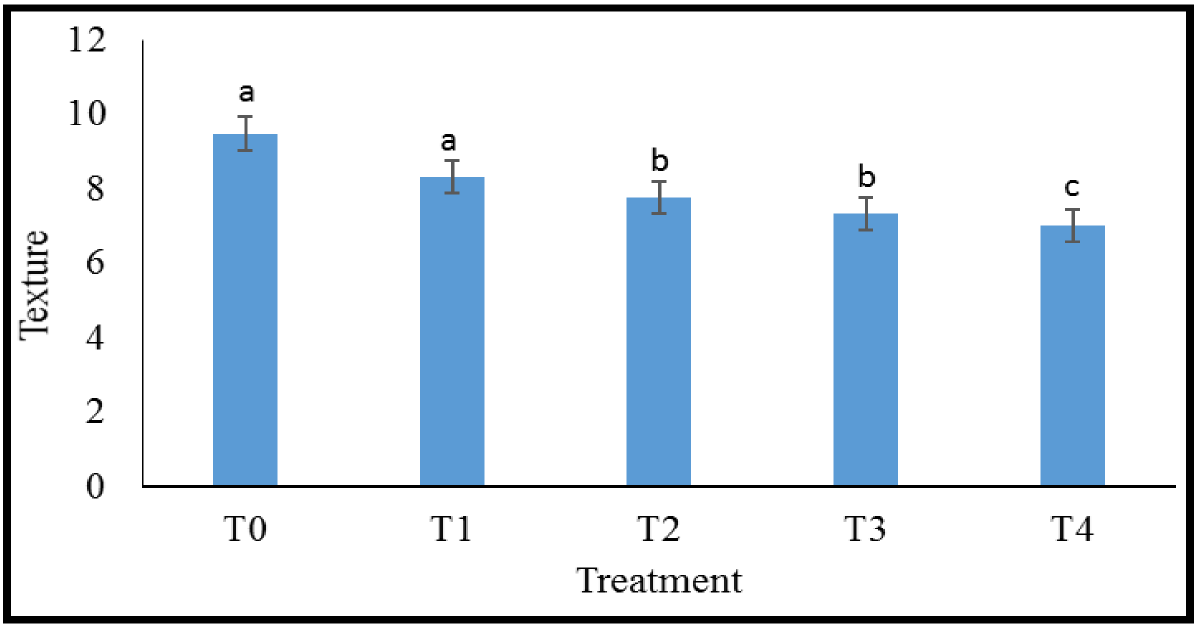

Fig. 9. Mean values of texture (%) in supplemented chocolate.

Carbohydrates

Carbohydrate content was present in chocolate shown the significance difference ($p > 0.05$) among all the level of fortification of moringa leaves powder. Mean values with standard deviation for carbohydrates content shown in Fig.6. Minimum value for carbohydrate content in chocolate (51.400) was found in 20 % moringa leaves powder fortification level. Similarly, maximum value (58.540) was found in 0 % moringa leaves powder fortification level respectively, moderate carbohydrate content was found (53.750) and (52.580) in 10 % and 15 % moringa leaves powder fortification level. These results were found in accordance with the results of (Ijarotimi, Fagbemi, & Osundahunsi, 2013) who reported a significant decrease in carbohydrate content was in response to increase in supplementation of moringa leaves powder in chocolate.

Sensory Evaluation of Supplemented Chocolate

Color**:** Color is most important factor in chocolate appearance because the acceptance and rejection of the product depend upon its physical appearance. Highest value was found in T0 (9.3) as shown in Fig.7. T4 depicted the lowest value of color (7) as followed by T1 (8.4), T2 (7.8) and T3 (7.5) respectively. As the above discussion it has been investigated that increase in concentration of moringa leaves powder may cause darkness in color of chocolate. The color was negatively affected because of the appearance of the greenish brown color in these batches. From the sensory evaluation results, it could be concluded that moringa leaves powder could be used in chocolate fortification at level up to 15% of cocoa powder blend used in chocolate making. This result is in line with the finding of (Abou-Zaid and Nadir, 2014).

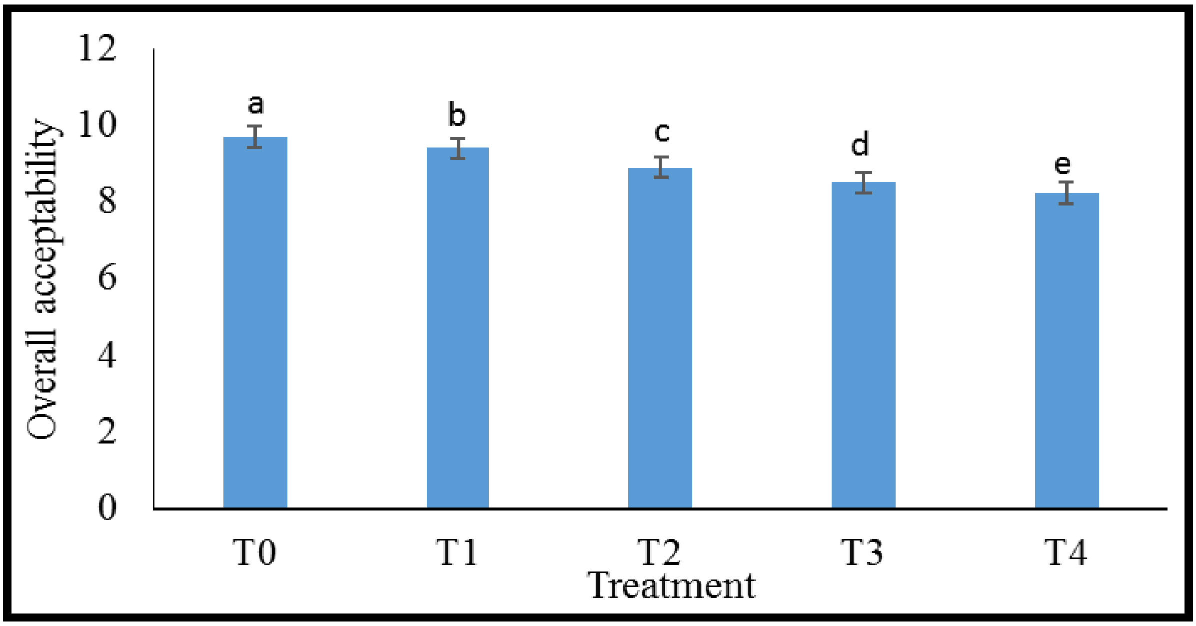

Fig. 10. Mean values of overall acceptability (%) in supplemented chocolate.

Taste**:** Tasteof the chocolate is an important parameter regarding the sensory evaluation to with the well-being feeling the mouth of consumer when eat it.

Analysis of variance for the sensory evaluation analysis of taste shows the significant variation among all the level of supplementation of moringa leaves powder in the chocolate in Fig.8. It was shown that the maximum value (9.5) for taste found in 0% moringa leaves powder of fortification and followed by (8.33) in 5 % moringa leaves powder, (7.76) in 10 % moringa leaves powder, and (7.33) in 15 % moringa leaves powder concentration. Similarly, minimum value (7.03) was found in 20% moringa leaves powder fortification chocolate. The taste was negatively affected because of the bitterness of chocolate increased by the incorporation of moringa leaves powder. From the sensory evaluation results, it could be concluded that moringa leaves powder could be used in chocolate fortification at level up to 15% of cacao powder blend used in chocolate making. These results were in accordance with result of (Abou-Zaid and Nadir, 2014).

Texture**:** Texture of the chocolate is also an important parameter regarding the sensory evaluation. Analysis of variance for the sensory evaluation analysis of texture shows the significant variation among all the level of supplementation of moringa leaves powder in the chocolate in Fig.9.

It was shown that the maximum value (9.7) for texture found in 0% moringa leaves powder of fortification and followed by (9.6) in 5 % moringa leaves powder, (9.3) in 10 % moringa leaves powder, and (9.0) in 15 % moringa leaves powder concentration. Similarly, minimum value (8.7) was found in 20% moringa leaves powder fortification chocolate.

These results were in accordance with result of Abou-Zaid and Nadir, (2014) who indicated that addition of moringa leaf powder gave a rough surface to the produced chocolate.

Overall acceptability**:** Overall acceptance for the chocolate which form by the supplementation of moringa leaves powder is the composite of all the other sensory evaluation principles (taste, color and texture). Analysis of variance for overall acceptance of chocolate was shown the significant variation among all the treatment of supplementation of moringa leaves powder in cookies in Fig.10.

It was shown that maximum value (9.7) found in 0%. Moringa leaves powder fortification followed by (9.4) in 5% moringa leaves powder fortification, (8.9) in 10% moringa leaves powder fortification and (8.5) in 15% moringa fortification. Respectively, minimum value (8.23) for overall acceptance was found in 15% moringa leaves powder level. These results were similar with the result of (Abou-Zaid an Nadir, 2014).

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