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PRODUCTION AND QUALITY EVALUATION OF HERBAL TEA FROM *MORINGA* LEAVES AND LEMON PEEL POWDER

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ABSTRACT
Tea is one of the most widely consumed beverages in the world next to water. It is made from tea leaves of Camellia sinensis. Herbal teas on the other hand, are tea variants not made from Camellia sinensis but from other plants, herbs, roots and plant extract. This study therefore, investigated the quality and acceptability of herbal teas made from dried Moringa leaves and lemon peel powder. Herbal teas were made from 100% dried Moringa leaves, 100% dried lemon peel powder and blends of Moringa leaves and lemon peel powder in the ratios of 50:50, 30:70 and 60:40. A total of five formulations were obtained. Using standard analytical methods, the proximate composition, vitamin content, phytochemical contents, chemical and sensory properties of all the tea formulations were investigated. Results obtained were compared to the control which was the Lipton Yellow brand tea. The result of the proximate composition revealed that the herbal teas formulated, compared favourably with the control (Lipton Yellow brand tea). The vitamin contents of all herbal tea formulated were relatively high compared to that obtained in the control. The phytochemical contents of the tea samples showed that the herbal teas contained significant levels of alkaloids, phenols, flavonoids and phytates. Tea made from 100% Moringa leaves was generally accepted and preferred over the control. It was concluded that herbal tea from 100% Moringa leaves and lemon peel powder has therapeutic potentials and high nutritional value and therefore can thrive commercially in the tea market.

Keywords: Herbal tea, *Camellia sinensis,* Yellow label tea, chemical, phytochemicals

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INTRODUCTION
Tea is ranked as one of the important world foods and is one of the most widely consumed beverages in the world next to water (Schmidt *et al*., 2005). It is a traditional beverage originally from China prepared by brewing processed leaves of the tea plant, *Camellia sinensis* and overtime, it has become the oldest, most popular, non-alcoholic caffeine containing beverage in the world (Kumar and Shruthi, 2014). Tea made from *Camellia sinensis* can be presented as black, yellow, white and oblong tea. However, each has its unique flavor and property determined by the degree and type of processing employed (Toyb *et al.*, 2016). Tea has been found to protect against neurological alterations that are induced by toxins present in the environment (Cho *et al.,* 2008) and occasional consumption of tea can also protect against mutations in humans resulting from ultra-violet radiation (Malhomme *et al.,* 2010). Tea also contains theanine and catechins whose antioxidant properties exhibit neuro-protective and free radical scavenging abilities respectively (Kakuda, 2002; Xu *et al.,* 2010). The utilization of plants and plant extracts in tea production has led to tea variants generally called "herbal tea" which are not produced from *Camellia sinensis*

leaves. Herbal tea is produced from brewing mixtures of herbs, fruits, seeds, leaves or plant extracts of various plants (Ravikumar, 2014). *Moringa* is a sole genus in the flowering plant family, *Moringa*ceae. All its parts are not only edible but also healthy, nutritious and with numerous potential uses (Fahey, 2006). It has medicinal and antioxidant properties and contains a variety of proteins, vitamins and minerals (*Kamal,* 2008). Research has also shown that *Moringa* is extremely low in fats and contains no harmful cholesterol (Bernett *et al.,* 2003). In addition, *Moringa oleifera* leaves also have various biological activities including the prevention of anemia in both children and adults (Singh *et al.*, 2018).

The lemon tree is an important medicinal plant of the family *Rutaceae.* Lemon is a citrus and citrus fruits have been reported to contain bioactive compounds. The most important being ascorbic acid which prevents and cures scurvy. It also contains polyphenols (Aronson, 2001). Research has also shown that lemons have rich antioxidant properties which play vital role in the production of collagen needed in the relief of asthmatic symptoms. They also have high potentials to protect against cancer and stroke (Ware, 2019). The lemon peels which are usually considered a waste material actually contain higher amounts of phytochemicals and volatile essential oils with higher antioxidant and antimicrobial properties (Shahnah *et al.,* 2007). They also contain many polymethoxylated flavones which are rarely present in other plants (Ahmad *et al.,* 2006).

The sensory perception of a product by a consumer is very crucial for it to thrive in the market irrespective of its health or nutritional benefits (George *et al*., 2021). Phenolic compounds such as tannins are well known for eliciting negative consumer response because of their astringency and bitter taste. This probably explains the poor sensory appeal of herbal teas produced solely from *Moringa* leaves or lemon peel despite their nutritional and therapeutic benefits. The perceived astringency and bitter taste therefore, could be one major factor limiting their use as sole components of herbal tea during herbal tea production (Ware, 2019). This study aimed at producing different herbal teas from dried *Moringa* leaves and lemon peels powder and determining the chemical, phytochemical, physicochemical and sensory properties of the herbal tea samples.

Materials and Methods

Sample Procurement

Fresh *Moringa* leaves were harvested from National Root Crop Research Institute (NRCRI) Umudike, while lemon and Lipton Yellow label tea were purchased from Ubani Main Market, all in Abia State, Nigeria.

Sample Preparation

Production of *Moringa* Leaves Powder

Freshly harvested leaves of *Moringa oleifera* were cleaned, washed under running tap water and then steam blanched for 60 seconds. The blanched leaves were drained in perforated plastic screen and dried at 60^0C for 48h in a hot air electric oven (MemertGmbt, type UNB 500, 8.7A, 22WNen temperature 220^0C, made in Germany). Thereafter, the dried leaves were ground with electric blender (Kenwood BL300, 220v-240v) and sieved through a 250mm mesh sieve to obtain fine flour. The flour was then packaged in a transparent polyethylene bag at ambient temperature (23^0C) for further use.

Production of Lemon Peel Powder

The lemon fruits were sorted, washed and peeled. The lemon rinds were sliced into thin strips and dried at 95^0C for 10h in a hot air electric drying oven (Memert Gmbt, type UNB 500, 8.7A, 22WNen temperature 220^0C, made in Germany). The dried peels were then ground using electrical blender (Kenwood BL300, 220v-240v) and sieved through a 250 mm mesh sieve to obtain fine flour. The flour was then packaged in a transparent polyethylene bag at ambient temperature (23^0C) for further use.

Formulation of *Moringa* Leaves and Lemon Peel Herbal Tea

Dried *Moringa* leaves and lemon peel powders were blended in varying proportions (100% dried Moringa leaves, 100% dried lemon peel powder and blends of Moringa leaves and lemon peel powder in the ratio of 50:50, 30:70 and 60:40) to obtain five different formulations (Table 1). Lipton yellow label tea served as control.

Chemical Analysis

The chemical analysis including: moisture, protein, fat, fibre, ash contents, total solid, specific gravity and total carotenoid were determined according to the method as described by Onwuka (2018) while the pH and total titrable acidity (TTA) were determined according to the method described by AOAC (2010).

Determination of Phytochemical properties of the tea samples

Alkaloid content was determined according to the method described by Harbone (1973) and Okwu and Morah (2007). Tannin content was determined using the method described by Onwuka (2005). Saponin content was determined according to the method described by Okwu and Morah (2007) and Obodoni and Ochuko (2011). Phenol content was determined according to the method as described by AOAC (2010**).** Flavonoid content was determined according to the methods described by Okwu and Omodamiro (2005). Phytate content was determined by the colorimeter method as described by Onwuka (2018).

Determination of Vitamin Contents of the Tea samples

Vitamin B1, B6 and E were determined according to the method described by Onwuka (2018) while Vitamin C was determined using the method described by Okwu and Josiah (2006).

Sensory Analysis

Sensory properties were determined according to the method described by Iwe (2014). A total of 30 panelists evaluated the organoleptic attributes (appearance, taste, texture, aroma and general acceptability) of the tea samples using a 9 point Hedonic scale.

Experimental Design

The experimental design for this study was a Completely Randomized Design (CRD).

Statistical Analysis

All experiments in this study were reported as means of triplicate determinations. One way analysis of variance were carried out using the Statistical Product of Service Solution (SPSS) version 22.0 to compare between the mean values while treatment means were separated using Duncan multiple range test at 95 % confidence level ($p<0.05$).

RESULTS AND DISCUSSION

Chemical analysis of herbal tea produced with *Moringa* leaves and lemon peels

The results of the chemical composition of the tea samples are presented in Table 2. The moisture content of the tea samples ranged from 3.10-6.06%. The result revealed that the control (Yellow label Lipton tea) sample had the highest moisture content (6.06%) which was significantly ($p<0.05$) different from the herbal tea samples. It was also observed that all the *Moringa* tea samples recorded lower moisture content than the 100% lemon peel tea. According to Muhammad *et al*. (2013) high levels of moisture (above 3-7%) in tea samples may result in quality deterioration. The lowest moisture content recorded for 100% *Moringa* leaf tea (3.10%) is an indication that the tea sample will have a longer shelf life. Higher crude protein value (11.42%) was obtained for 100% *Moringa* leaf tea compared to a significantly ($p<0.05$) low value recorded for the control (0.11%). According to Singh *et al.* (2018) dried *Moringa* leaves contain nine times the protein found in yoghurt. This implies that

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consumption of 100% *Moringa* tea can be recommended for people who are prone to protein malnutrition. In terms of fat content, all tea blends recorded lower values than that recorded for the control (2.38%) therefore, they can be recommended in a weight loss diet (Ware, 2019). The crude fibers present in food have little food value but provide the bulk necessary for proper peristaltic action in the intestinal tract. They give a satiety effect to the consumer thus, reduces energy intake. The fibre content of the tea samples were found to be highest (7.06%) in 100% *Moringa* leaves tea and was significantly different ($p<0.05$) from the other tea samples.

The ash content is a measure of the nutritionally important mineral contents found in the food material (Omotosho, 2005). The 100% *Moringa* leaves tea recorded the highest value of ash (7.93%) which was higher than that obtained by Arise *et al.* (2015) for ash content in *Moringa* flower. The high ash content value in 100% *Moringa* leaves tea can be attributed to its high potassium and calcium contents which were reported by Singh *et al.* (2018) to be 15 times the potassium found in banana and 17 times the calcium found in milk.

Carotenoid and vitamin composition of herbal tea produced with *Moringa* leaves and lemon peels

Carotenoid content in foods is an indication that the food is capable of ameliorating oxidative stress caused by reactive oxygen species and reducing the risk of breast cancer (Eliassan *et al*., 2012). Therefore, tea sample produced from 100% lemon peel has this capacity as it recorded a significantly high carotenoid content (5.52µg/100g) compared to the value obtained from the control (1.71µg/100g). However, the 100% *Moringa* leaves tea recorded the lowest carotenoid content (1.52µg/100g). It was observed that the value of carotenoid content reduces as the addition of lemon peel powder reduces.

Thiamine, also known as vitamin B1, is a vitamin found naturally in some foods. However, due to its nutritional importance in humans, it has also been manufactured as a dietary supplement. The results of the vitamin (Table 3) revealed that 100% *Moringa* leaves tea recorded the highest value of Vitamin B1 (0.78mg/100g) and the same trend was observed for all the vitamins investigated (Vitamins B6, C and E). In this study, it was observed that as the addition of *Moringa* leaves tea increases, the values of the vitamins studied increased. This is good evidence that *Moringa* leaf is a good source of these vitamins studied. The 100% *Moringa* leaves tea recorded the highest value (1.02mg/100g) of vitamin B6 followed by *Moringa* leaf-lemon peel tea blend (70:30) which recorded vitamin B6 value of 0.85 mg/100g. Hellmann and Mooney (2010) reported that vitamin B6 is a potent antioxidant and is also an essential molecule in cellular metabolism in humans.

Vitamin C, also known as ascorbic acid, is a vitamin found in various foods and sold as a dietary supplement. It is used to prevent and treat scurvy. It is an essential nutrient involved in the repair of tissue and the enzymatic production of certain neurotransmitters (Hemila, 2017). Relatively high vitamin C content (20.64mg/100g) was recorded for tea produced from 100% *Moringa* leaves. *Moringa* leaves have been reported by (Singh *et al.,* 2018) to contain ten times more vitamin C than oranges.

Vitamin E is a fat soluble vitamin with high antioxidant property. Tea produced from 100% *Moringa* leaf recorded the highest thiamine content value (0.78mg/100g) and vitamin E content (24.87mg/100g). This is an indication that the tea has anti-cancer and anti-ageing potentials when consumed (Saliha *et al*., 2014).

Phytochemical properties of herbal tea blended from *Moringa* leaves and lemon peels

The result of the phytochemical properties of the tea samples are presented in Table 4.

Alkaloids are a class of naturally occurring organic compounds that mostly contain basic nitrogen atoms. Tannins on the other hand, are a class of astringent, polyphenolic biomolecules that bind to and precipitate proteins and other organic compounds such as amino acids and alkaloids. Tannins therefore, play a role in physiological effects in the human body (Kasolo *et al*., 2010). The high alkaloid and tannin content values recorded by 100% *Moringa* leaf tea is indicative of its pharmacological potentials such as analgesic, anti-hyperglycemic, anti-cancer etc.

Herbal tea produced from 100% *Moringa* leaf recorded highest values for saponins and phytates of 1.5 and 1.25mg/100g respectively. Saponins have anti-carcinogenic properties, immune modulation activities and regulate cell proliferation therefore; it inhibits the growth of cancer cells (Shi *et al*., 2004). Dietary phytate plays a role in the prevention of kidney stone formation as well as in the protection against cancer, diabetes mellitus, caries, atherosclerosis and coronary heart disease.

The 100% Moringa leaf tea may have anti-carcinogenic and anti-mutagenic potentials as well as a high antioxidant activity (Kozłowska and Szostak-Wegierek, 2014) due to its relatively high phenolic and flavonoid contents compared to the other tea blends in this study. Although flavonoids are found in almost all fruits and vegetables, they are responsible for their vivid colors. Phenols on the other hand, are described as chemical compounds consisting of a hydroxyl group bonded directly to an aromatic hydrocarbon group.

Physicochemical content of herbal tea blended from Moringa leaves and lemon peels

The physicochemical composition of the blended tea samples is shown in table 4. The pH of a food material specifies how acidic or basic a water-based solution is. Acidic solutions have a lower pH, while basic solutions have a higher pH. The pH of the tea samples ranged from 4.36 – 6.07 There was significant difference ($p<0.05$) among the tea samples. The higher acidity of 100% lemon peel powder tea relative to other herbal tea blends in this study could be attributed to insufficient drying of the lemon peels.

Total solid is a measure of the total dissolved solids and total suspended solids in a liquid. A higher total solids level indicates that there is a high level of solid material in a liquid sample. Therefore, the high total solids value recorded by 100% *Moringa* leaf tea (96.90%) is an indication that it is concentrated with nutrients as reported by Kozłowska and Szostak-Wegierek (2014).

Titratable acid generally refers to any acid that can lose proton in an acid-base reaction. A titratable acid content value was recorded as 0.835% for 60:40 *Moringa* leaf-lemon peel powder tea. Therefore, it is advised that tea dilution must be done before consumption in order to reduce the acidity of the tea.

Specific gravity, also called relative density, is the ratio of the density of a substance to the density of a reference substance. The 100% *Moringa* leaf tea recorded the highest specific density value therefore, it can float on water.

Sensory evaluation of herbal tea blended from *Moringa* leaves and lemon peels

In terms of aroma, the 100% *Moringa* leaf tea recorded the highest value (4.95) while the 60:40 *Moringa* leaf-lemon peel powder tea recorded the lowest value (3.65). These values were significantly lower than that recorded for the control (8.45). This could probably be as a result of the high carbohydrate content of the control.

Appearance describes the physical outlook of a food. It is what the consumer first sees with the eyes. The control recorded higher acceptance in terms of appearance than the herbal tea blends.

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However, the 100% *Moringa* leaf tea recorded the highest value in appearance amongst the herbal tea blends. This perhaps could be due to the coarse appearances of the herbal tea blends.

In terms of mouth feel and taste, the 100% *Moringa* leaf tea had the highest acceptance and this could be attributed to the presence of menthol in the blended tea which gives a cooling effect in the mouth. The result of the general acceptance revealed that the 100% *Moringa* leaf tea had highest acceptability with a value of 6.0 which is higher than that of the control.

Conclusion

Production of herbal tea from *Moringa* leaves, lemon peel powder and their blends is not only cost effective but can also serve nutritional and therapeutic purposes due to the chemical and phytochemical constituents of the product. The use of lemon peel powder in tea production has added value to a material which ordinarily would have been disposed as waste. However, the astringency and bitterness of tea produced from both raw materials can be a downside in its full commercialization.

Recommendation

The herbal teas produced in this study have recorded significant nutrient contents. However, further studies can be done on the reduction of the astringency and bitterness of the tea produced in order to increase its market potential in the tea market.

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APPENDICES

Table 1: *Moringa* leaves and lemon peel herbal tea formulations

Sample Code	*Moringa* leaf powder	Lemon peel powder
MLP100	100	-
LPP100	-	100
MLP70 : LPP30	70	30
MLP60 :LPP40	60	40
MLP50 : LPP50	50	50

Where; MLP=*Moringa* leaf powder; LPP=lemon peel powder

MLP100 = 100% *Moringa* leaf, LPP100 = 100% lemon peel powder, MLP70:LPP30 = 70% *Moringa* and 30% lemon, MLP60:LPP40 = 60% *Moringa* and 40% lemon, MLP50:LPP50 = 50% *Moringa* and 50% lemon.

Table 2: Chemical composition (%) of lipton and herbal tea produced from *Moringa* leaves and lemon peels

Sample	Moisture	Protein	Fat	Fibre	Ash
Control(Yellow Label Lipton Tea)	$6.06^{a}\pm0.01$	$0.11^{f}\pm0.01$	$2.38^{d}\pm0.01$	$2.05^{f}\pm0.01$	$4.38^{e}\pm0.01$
MLP100	$3.10^{f}\pm0.01$	$11.24^{a}\pm0.01$	$1.22^{f}\pm0.01$	$7.06^{a}\pm0.01$	$7.93^{a}\pm0.01$
LPP100	$5.74^{b}\pm0.01$	$2.59^{e}\pm0.01$	$1.99^{b}\pm0.01$	$6.21^{e}\pm0.01$	$2.15^{f}\pm0.01$
MLP70 : LPP30	$3.89^{d}\pm0.01$	$8.63^{b}\pm0.01$	$1.44^{e}\pm0.01$	$6.82^{b}\pm0.01$	$6.16^{b}\pm0.01$
MLP60 : LPP40	$3.12^{e}\pm0.01$	$7.76^{c}\pm0.01$	$1.53^{d}\pm0.01$	$6.71^{c}\pm0.01$	$5.60^{c}\pm0.01$
ML50 : LPP50	$4.42^{c}\pm0.01$	$6.88^{d}\pm0.01$	$1.59^{c}\pm0.01$	$6.65^{d}\pm0.01$	$5.05^{d}\pm0.01$

Values are mean ± SD of triplicate determinations. Means with different superscripts down the column are significantly ($p<0.05$) different. Keys: MLP-*Moringa* leaf powder; LPP – Lemon peel powder.

Table 3: Carotenoid and vitamin contents of herbal tea produced from *Moringa* leaves and lemon peels powder

SAMPLE	Carotenoid (µg/100g)	B_1 (mg/100g)	B_6 (mg/100g)	C (mg/100g)	E (mg/100g)
Control(Yellow Label Lipton Tea)	1.71^{e}±0.02	0.52^{f}±0.01	0.61^{e}±0.01	8.67^{e}±0.01	11.98^{e}±0.01
MLP100	1.52^{f}±0.01	0.78^{a}±0.01	1.02^{a}±0.01	20.64^{a}±0.01	24.87^{a}±0.01
LPP100	5.52^{a}±0.12	0.68^{e}±0.01	0.45^{f}±0.01	3.01^{f}±0.01	8.39^{f}±0.01
MLP70 : LPP30	2.61^{d}±0.12	0.76^{b}±0.01	0.85^{b}±0.01	15.34^{b}±0.01	19.9^{b}±0.01
MLP60 : LPP40	3.13^{c}±0.01	0.73^{c}±0.01	0.78^{c}±0.01	13.58^{c}±0.01	18.29^{c}±0.01
MLP50 : LPP50	3.52^{b}±0.01	0.70^{d}±0.09	0.73^{d}±0.01	11.84^{d}±0.01	16.62^{d}±0.01

Values are mean ± SD of triplicate determinations. Means with different superscripts down the column are significantly ($p<0.05$) different. Keys: MLP-*Moringa* Leaf Powder; LPP - Lemon peel powder

Table 4: Phytochemical properties of herbal tea produced from *Moringa* leaves and lemon peels powder

SAMPLE	Alkaloid (mg/100g)	Tannin (mg/100g)	Phytate (mg/100g)	Saponin (mg/100g)	Flavonoid (mg/100g)	Phenol (mg/100g)
Control (Yellow Label Lipton Tea)	0.73^{e}±0.01	5.64^{f}±0.01	2.18^{b}±1.17	0.38^{e}±0.17	2.62^{a}±0.01	1.13^{b}±0.01
MLP100	1.64^{a}±0.01	16.20^{a}±0.01	4.10^{a}±2.10	1.51^{a}±0.01	2.02^{b}±0.01	1.25^{a}±0.01
LPP100	0.53^{f}±0.01	0.51^{e}±0.01	0.11^{f}±0.01	0.12^{f}±0.01	0.11^{e}±0.01	0.41^{c}±0.01
MLP70 : LPP30	1.29^{b}±0.01	11.50^{b}±0.01	1.83^{c}±0.01	1.09^{b}±0.01	2.02^{b}±0.01	0.14^{f}±0.01
MLP60 : LPP40	1.21^{c}±0.01	9.92^{c}±0.01	1.58^{d}±0.01	0.95^{c}±0.01	1.27^{c}±0.01	0.17^{e}±0.01
MLP50 : LPP50	1.10^{d}±0.01	8.35^{d}±0.01	1.34^{e}±0.01	0.82^{d}±0.01	1.20^{d}±0.01	0.23^{d}±0.01

Values are mean ± SD of triplicate determinations. Means with different superscripts down the column are significantly ($p<0.05$) different. Keys: MLP-*Moringa* leaf powder; LPP - Lemon peel powder

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Table 5: Physicochemical content of herbal tea produced with *Moringa* leaves and lemon peel powder

SAMPLE	pH	TS (%)	TTA (%)	SG (%)
Control(Yellow Label Lipton Tea)	5.06^{a}±0.01	93.94^{f}±0.01	0.47^{a}±0.01	2.05^{f}±0.01
MLP100	4.65^{f}±0.01	96.90^{a}±0.01	0.78^{f}±0.01	7.06^{a}±0.01
LPP100	4.02^{b}±0.01	94.26^{e}±0.01	0.57^{b}±0.01	6.21^{e}±0.01
MLP70 : LPP30	6.07^{c}±0.01	96.11^{b}±0.01	0.95^{e}±0.01	6.82^{b}±0.01
MLP60 : LPP40	5.21^{d}±0.01	96.88^{c}±0.01	0.83^{d}±0.01	6.71^{c}±0.01
MLP50 : LPP50	4.36^{e}±0.01	95.58^{d}±0.01	0.63^{c}±0.01	6.65^{d}±0.01

Values are mean ± SD of triplicate determinations. Means with different superscripts down the column are significantly different ($p<0.05$). Keys: MLP -Moringa Leaf Powder; LPP - Lemon peel powder; TS – Total solids, TTA – Total titratable acids; SG – Specific gravity.

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Table 6: Sensory Evaluation of Herbal Tea produced with *Moringa* Leaves and Lemon Peel Powder

Sample	Aroma	Appearance	Mouth Feel	Taste	General Acceptability
Control(Yellow Label Lipton Tea)	8.45^{a}±0.60	6.60^{a}±0.01	2.20^{a}±0.01	4.40^{a}±0.01	5.50^{a}±0.01
MLP100	4.95^{b}±0.73	5.35^{b}±0.01	4.55^{b}±0.01	4.70^{b}±0.01	6.00^{b}±0.02
LPP100	3.75^{e}±0.86	4.95^{c}±0.01	3.25^{e}±0.01	3.15^{d}±0.01	3.70^{c}±0.01
MLP70 : LPP30	3.90^{c}±0.01	4.55^{e}±0.01	3.65^{c}±0.01	3.15^{d}±0.01	3.60^{d}±0.01
MLP60 : LPP40	3.65^{f}±0.02	4.30^{f}±0.01	3.30^{d}±0.01	3.40^{c}±0.01	3.60^{d}±0.01
MLP50 : LPP50	3.85^{d}±0.01	4.75^{d}±0.02	3.20^{f}±0.01	2.85^{e}±0.01	3.25^{e}±0.02

Values are mean ± SD of triplicate determinations. Means with different superscripts down the column are significantly different ($p<0.05$). Keys: MLP -*Moringa* Leaf Powder; LPP - Lemon peel powder;