EFFECT OF NATURAL ANTIOXIDANT AND PACKAGING ON STABILITY OF BEEF PRODUCT STORED UNDER REFRIGERATED CONDITION

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Abstract

Moringa Oleifera Lam.(Moringaceae) leaves powder was used as a natural antioxidant in combination with packaging treatment to study the stability of beef product (meat balls) during cold storage. The data showed that the samples treated with Moringa powder and packaged in LDPE bags had higher moisture content, cooking characteristics than the untreated and unpackaged ones. The changes in the pH, TBA values and microbial growth rate were minimal for the Moringa treated and packaged samples compared to the control unpackaged ones.

Key words: Natural antioxidant, Moringa Oleifera, beef products, cold storage, packaging

INTRODUCTION

Lipid oxidation and bacterial contamination are the main factors that determine food quality loss and shelf life reduction. Therefore, delaying lipid oxidation and preventing bacterial cross-contamination are highly relevant to food processors [11]. During production, processing, distribution, and storage, food undergoes deterioration from chemical and microbiological processes [14]. Oxidation is a major cause of that deterioration because of its negative effects on organoleptic qualities (flavor, color, etc.). Oxidation of lipids can also have a marked negative effect on nutritional value, and could be responsible for the production of toxic compounds [18].

Meat as a food has a complex physical structure and chemical composition that is very susceptible to oxidation [26], [21]. The oxidative stability of meat depends upon the balance and the interaction between endogenous anti- and pro-oxidant substances and the composition of substrates prone to oxidation including poly unsaturated fatty acids (PUFA), cholesterol, proteins and pigments [9]. Due to detrimental effects of lipid oxidation on color, flavor, texture, and nutritional value of foods; addition of synthetic antioxidants such as BHT and BHA has been effective because of their low cost, high stability, and effectiveness.

The use of antioxidants in lipids and lipid containing foods is one method to minimize rancidity, retard the formation of toxic oxidation products, maintain nutritional quality and increase the shelf life of food products. However, the use of such compounds has been related to health risks resulting in strict regulations over their use in food products and this has stimulated research for alternative antioxidant sources [16].

With increased consumer concerns about the amount of chemicals in their foods, processors are looking for more natural ways to protect their products. In the last few years, there has been an increasing interest in the use of natural additives in preference to synthetic substances for the stabilization of fat-containing food stuff. [20], [7]. Natural antioxidants present in foods and other biological materials have attracted considerable interest because of their presumed safety and potential nutritional and therapeutic value. Natural antioxidants, especially phenolics and flavonoids, are safe and also bioactive. The natural antioxidants have been studied in meat from a huge number of plant sources. Some of these natural antioxidants are also available commercially and several studies have been

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carried out by different researchers applying commercially available natural antioxidants of plant origin to meat [21].

The increased interest in natural antioxidants has led to the antioxidant evaluation of many species of fruits, vegetables, herbs, spices and cereals [25], [17]. For this reason, there is growing interest in separating these plant antioxidants and using them as natural antioxidants.

Moringa Oleifera Lam. (Moringaceae) leaves have been reported to be a good source of natural antioxidants and, thus, enhance the shelf life of fat-containing foods due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids [22], [1]. Polyphenolic compounds acts as chain-breaking peroxyl radical scavengers which lead to the inhibition of lipid peroxidation and also prevent low-density peroxidation [19].

The objective of this investigation is to study the effect of adding Moringa Oleifera leaves powder as a natural antioxidant and packaging on stability of beef product during cold storage.

MATERIALS AND METHODS

Moringa Oleifera Lam. (Moringaceae) was obtained from a private farm, the leaves were oven dried at 45 ºC, then ground to obtain a 60 mesh powder.

Fresh beef used in this study was obtained from the local market, one hour after slaughter. The sample was trimmed and hold at 4ºC for 24 hours and then ground. The ground sample then divided into two groups, one group was left as control while the other group was mixed with 1.5% (w/w) Moringa Oleifera leaves powder. Each group was used to make beef product (meatballs) according to the formula showed in (Table 1). Meatballs in each treatment were displayed on polystyrene trays and divided into two groups. One group was packaged in LDPE pages, while the other group was left unpackaged. All treatments were stored at refrigerated condition (4±1°C for 15 days) for investigation Fig. 1.

Table 1 Meatballs formula

Ingredients		%
Minced beef		82.4
Onion		3.0
Garlic		0.5
Bread crumb powder		8.0
Spice mixture		4.1
Salt		2.0

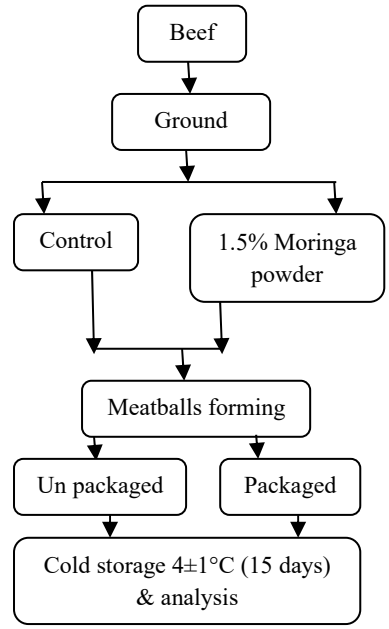


Fig. 1 Flow diagram of production of beef product stored under refrigerated condition

Determination of moisture content: Moisture content was determined according to the method of [5].

pH measurement: A slurry was prepared by blending the meat product (5g/50ml distilled water). The pH of this slurry was measured by using the glass-electrode method according to [4].

Determination of expressible water (EP) and water holding capacity (WHC): Expressible water (EP) was determined according to [2]. Whereas, water holding capacity (WHC) was calculated.

Thiobarbituric acid (TBA) value: All the investigated samples were tested separately in duplicate according to the method of [13]. Colorimetric absorbance at 530 nm was measured using a Spectronic 710 spectrophotometer. Readings were converted

at mg malonaldehyde/kg sample and reported as TBA values (mg TBA/kg meat).

Microbiological test: Total plate count of control and treated beef product were made as (CFU/g) according to the methods described in the standard methods of [6], [24].

Cooking loss: Cooking loss of the control and treated beef samples were determined according to the method of [3] by using the following equation:

$$\% \text{ Cooking loss} = \frac{RSW - CSW}{RSW} \times 100$$

Where;
RSW = Raw sample weight
CSW = Cooked sample weight

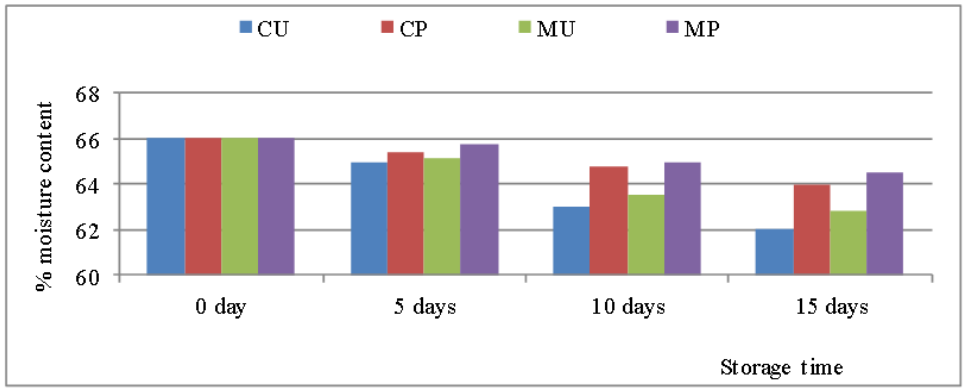
Cooking yield: Cooking yield of the control and treated beef samples were calculated according to [10] by using the following equation.
% Cooking yield = 100 - % Cooking loss

Statistical analysis: Data were analyzed by analysis of variance (ANOVA) to determine if treatments were significantly different [12].

RESULTS AND DISCUSSION

Figure 2 illustrates the effect of natural antioxidant (Moringa Oleifera) powder, and packaging treatment on the moisture content of the beef product (meat balls) stored for 15 days under refrigerated condition.

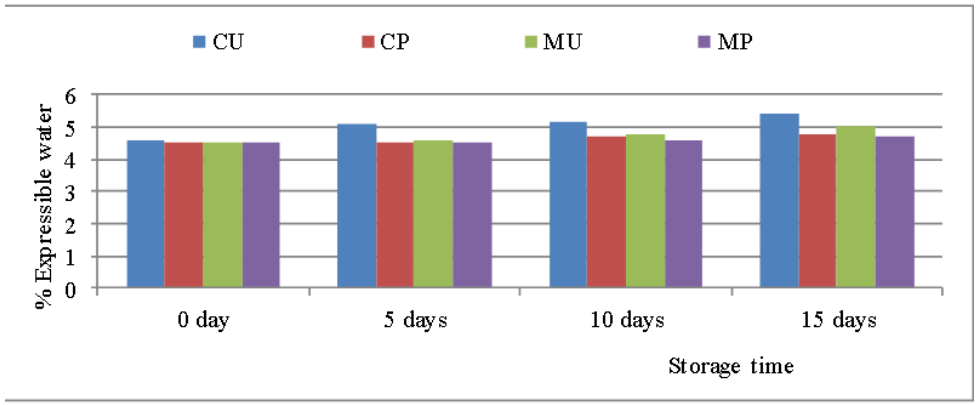
It is shown from the results that all the samples have lost moisture during the storage period. The loss was higher in the unpackaged treatment samples compared with the packaged ones. This indicated that LDPE bags have protection effect against water vapor permeation. Samples treated by 1.5% Moringa Oleifera leaves powder have a little higher moisture content compared with the untreated samples, which means that the addition of Moringa Oleifera powder has little effect of keeping moisture in the samples.



CU = control unpackaged. CP = control packaged. MU = 1.5% moringa powder unpackaged. MP= 1.5% moringa powder packaged.

Fig. 2 Effect of natural antioxidant and packaging on the moisture content of refrigerated beef product

The effect of storage time, natural antioxidant, and packaging treatment on the expressible water (EW) and water holding capacity (WHC) of refrigerated beef product (meat balls) were shown in (Figures 3 & 4). The data showed that the (EW) values increased and the (WHC) values decreased along with the progressing in the storage time for all samples under investigation. The increment of (EW) and the reduction of (WHC) values were much higher in the unpackaged samples and less higher in the antioxidant treated samples, which means that the packaging treatment and the addition of Moringa Oleifera powder as natural antioxidant retarded the loss of moisture and kept the juiciness for the samples. This comes in agreement with what was found by [15]



CU = control unpackaged. CP = control packaged. MU = 1.5% moringa powder unpackaged. MP= 1.5% moringa powder packaged.

Fig. 3 Effect of natural antioxidant and packaging on the expressible water (EW) of refrigerated beef product

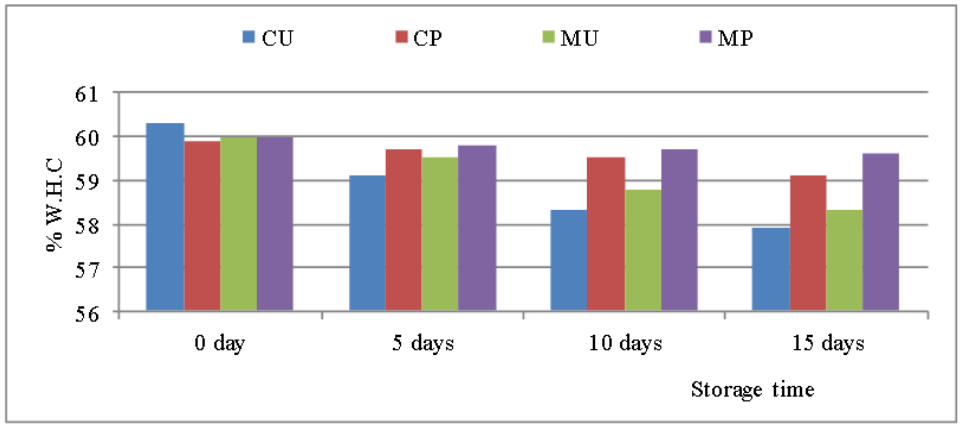


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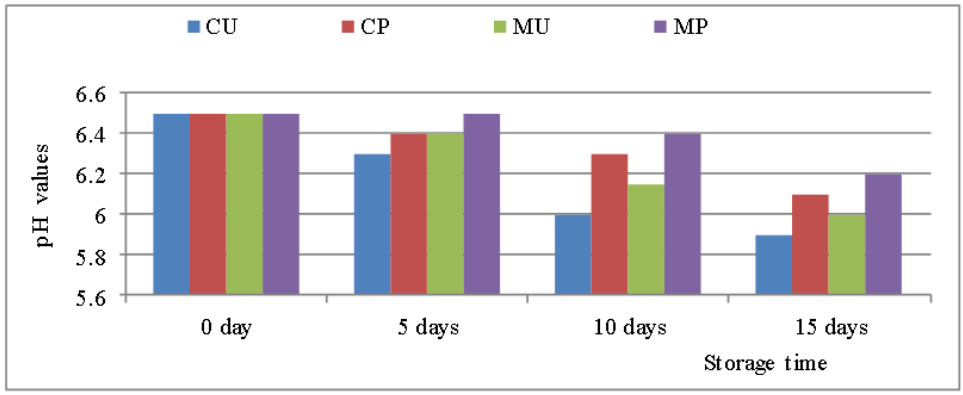
Fig. 4 Effect of natural antioxidant and packaging on the water holding capacity (WHC) of refrigerated beef product

Figure 5 clearly illustrates the effect of packaging treatment and natural antioxidant on the pH values for the beef product stored under refrigerated condition for 15 days. The data demonstrate that there is a decrease in the pH values with progressing in the storage period for all samples. The reduction in the pH values were much higher in the control unpackaged sample than the sample treated with Moringa Oleifera powder and packaged. This could be due to the effect of the addition of the natural antioxidant which retarded the formation of free fatty acids. It is also obvious that packaging treatment had negative effect on the formation of free fatty acids [15].

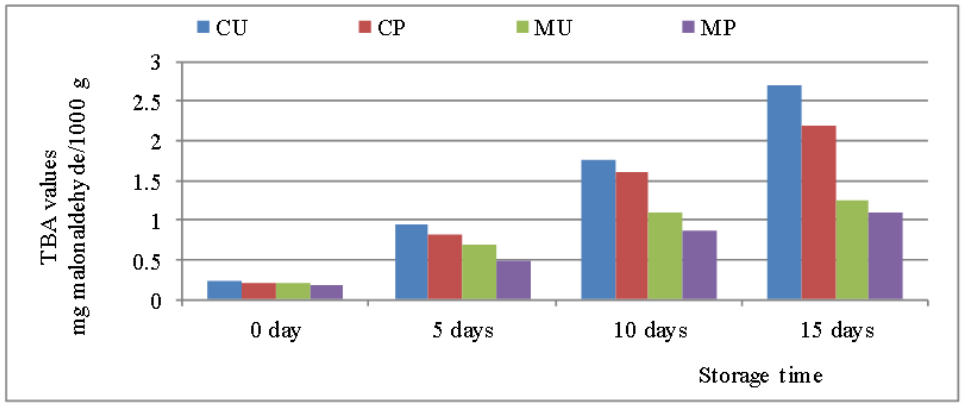


CU = control unpackaged. CP = control packaged. MU = 1.5% moringa powder unpackaged. MP= 1.5% moringa powder packaged.

Fig. 5 Effect of natural antioxidant and packaging on the pH values of refrigerated beef product

Data in Figure 6 shows the effect of storage time in combination with natural antioxidant, and packaging treatment on the (TBA) values of beef product during storage at 4±1°C. The data revealed that the addition of Moringa Oleifera leaves powder as natural antioxidant reduced the increase of (TBA) values along with the time of storage compared with the control ones. It is also showed that the packaging treatment had to some extent the same trend.

Moringa Oleifera leaves have been reported to be a good source of natural antioxidant, and thus, enhance the shelf life of fat containing food due to the presence of antioxidant compounds which lead to the inhibition of lipid preoxidation and also prevent low density peroxidation [8] and [23]

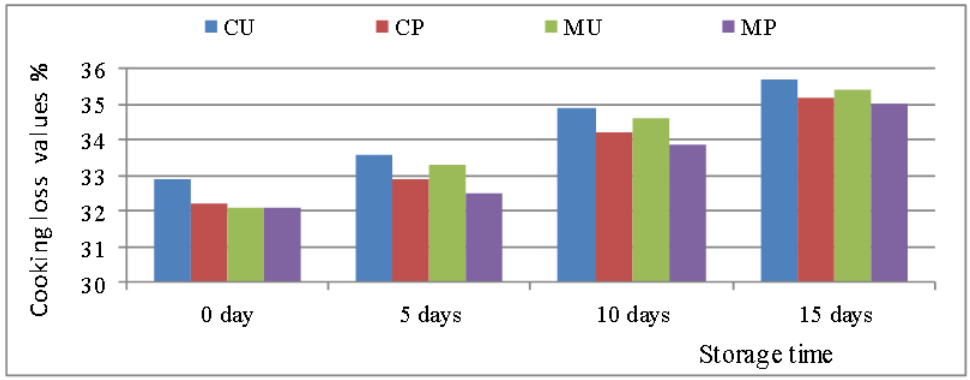


CU = control unpackaged. CP = control packaged. MU = 1.5% moringa powder unpackaged. MP = 1.5% moringa powder packaged.

Fig. 6 Effect of natural antioxidant and packaging on the TBA values of refrigerated beef product

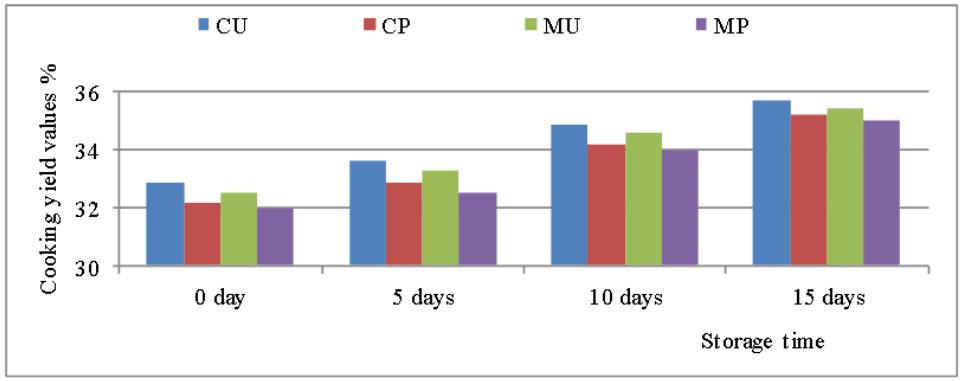
The cooking characteristics (cooking loss and cooking yield) of beef product treated with Moringa Oleifera leaves powder and stored packaged for 15 days at 4±1°C are shown in (Figures 7-8). The addition of Moring Oleifera powder to the meat balls affected the cooking characteristics of the product. The cooking yield values were increased while the cooking loss values were decreased for the meat balls treated by 1.5% Moringa Oleifera powder. The

addition of Moringa leaves powder as a natural antioxidant to beef product improves the cooking yield due to the fat and water retention capacity and capability to keep moisture in the meat balls matrix as reported by [11]. The addition of Moringa Oleifera leaves powder to beef product, and packaging treatment resulted in better cooking yield.



CU = control unpackaged. CP = control packaged. MU = 1.5% moringa powder unpackaged. MP= 1.5% moringa powder packaged.

Fig. 7 Effect of natural antioxidant and packaging on the cooking loss values of refrigerated beef product



CU = control unpackaged. CP = control packaged. MU = 1.5% moringa powder unpackaged. MP= 1.5% moringa powder packaged.

Fig. 8 Effect of natural antioxidant and packaging on the cooking yield values of refrigerated beef product

Protection of food from microbial or chemical deterioration has traditionally been an important concern in the food industry. Table 2 illustrates the effect of Moringa Oleifera leaves powder as natural antioxidant in combination with packaging treatment on the total bacterial count for beef product (meat balls) stored for 15 days under refrigerated condition. The data showed a positive relationship between the time of storage and the bacterial count for all samples. The rate of increment was higher in the control packaged and unpackaged samples. This is particularly evident for the inhibition effect of Moringa Oleifera leaves powder on the growth of bacteria. The data also revealed that the packaging treatment had a little negative effect on the growth of bacteria during the storage period.

Table 2 Effect of natural antioxidant and packaging on the total bacterial count of refrigerated beef product (CFU/g)

Storage time	CU	CP	MU	MP
0 day	11×10^4	11.5×10^4	7.5×10^4	7.5×10^4
5 days	23×10^4	12.5×10^4	10×10^4	8.5×10^4
10 days	48×10^4	17.5×10^4	17×10^4	10×10^4
15 days	12×10^5	29×10^4	23×10^4	19×10^4

CU = control unpackaged.
CP = control packaged.
MU = 1.5% moringa powder unpackaged.
MP= 1.5% moringa powder packaged.

CONCLUSIONS

Based on the above findings, it was concluded that use of Moringa oleifera leaves powder as a natural antioxidant at the level of 1.5% improved the quality of the beef product (meat balls) by delaying the oxidation of the product during cold storage. The study also clearly indicated that the treatment by Moringa leaf powder can be successfully used as a meat additive due to its strong effect in preventing the growth of bacteria and also in improving the cooking characteristics of the product.

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