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Mob: +92 300 3008585, Fax: +92 41 8815544
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Research Article
Evaluating the Quality and Shelf Life Attributes of a Multicomponent Meat Product (2)

[1]Nadia N. Al-Hajo, [2]S. Doley, [3]M. Yeater and [3]W.N. Osburn

[1]Department of Animal Resource, College of Agriculture, University of Baghdad, Baghdad, Iraq
[2]Indian Council of Agricultural Research, ICAR Complex for NEH Region, Shillong, India
[3]Department of Animal Science, Texas A&M University, College Station, TX 77843, USA

Abstract

Background and Objective: Nutrition and energy bars that use meat as the major protein source are considered intermediate moisture meat products. These products may provide a reasonably priced nutrient dense food for populations with less than desirable food security. The objectives of this study were to evaluate the sensory characteristics and shelf stability of the multicomponent meat product exposed to room temperature storage conditions. **Materials and Methods:** The multicomponent meat based product formulation was prepared from halal beef, dried dates, walnuts and nonmeat ingredients. Chopping and extrusion were used to create rectangular bars with a pH of 5.0 and a water activity of 0.85. The product was cooked at 70°C and chilled at 2°C prior to packaging(vacuum packaged). The product was then, stored (8 and 11 months) at room temperature, which ranged from 42-52°C .The sensory and microbial status of samples of the meat bars were evaluated. **Results:** The sensory characteristics significantly decreased ($p \leq 0.05$). According to the panelists, samples stored for 8 months were more acceptable ($p \leq 0.05$) in flavor, hardness, overall appearance and overall acceptance than samples stored for 11 months. The results also showed the absence of *Salmonella* and *E. coli* in meat bars products when stored at room temperature for 8 and 11 months. **Conclusion:** For developing countries with food security issues, protein bars are safe and show consumer acceptability over 8 months of storage.

Key words: Food security, multicomponent meat product, protein bars, sensory evaluation, total viable count

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Corresponding Author: Nadia N. Al-Hajo, Department of Animal Resource, College of Agriculture, University of Baghdad, Baghdad, Iraq

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

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

INTRODUCTION

Protein bars contain quality protein, sugars and other low molecular weight polyhydroxyl species, making them energy-dense confections with low water contents[1]. Protein bars were initially produced for athletes; however, they have been adapted to the needs of an extensive variety of health-conscious consumers. These bars contain 15-35% protein with the remainder being sugars and flavorings to generate taste. Flavor mixes, nuts, wafers, nuggets and so forth might be included to provide a novel texture and additional components to improve the dietary value[1]. There is, generally a significant gap between production and utilization, during which the product is transported and stored. During storage, various natural reactions will occur and a portion of these can create desirable or undesirable traits (according to consumers).

The shelf life can be characterized as the time that a product can be stored without becoming unfit for utilization, consumption and sale. Intermediate-moisture foods generally have water activities (aw value) in the range of 0.6-0.9[2], which is sufficiently low to suppress the growth of most microorganisms[3]. The shelf life of protein bars is constrained by the change in the texture (hard or tough) that causes it to be unpalatable to consumers. The component that controls the hardening of the protein bars has not been definitively identified[1].

Protein bars are common among buyers looking to curb hunger, reduce the risk of sarcopenia and expanded muscle mass[4]. Customers have turned to protein nutrition bars to add more protein to their diets. Protein meat bars are being more frequently consumed as a source of dietry protein[5]. In western nations, there is a growing fascination in traditional source of food because consumers believe such sources are more sustainable[6] for specific geographic regions and facilitate the employment of local individuals[6,7].

Shelf-stable products are those that do not require refrigeration or freezing for security or to maintain their organoleptic qualities. Meat protein bars are stored at room temperature and relying on the best possible wrapping to control oxidation and potential development of microorganism's. In this way, the shelf life of these products is generally limited by their quality and not by their security, because the safety of the product is controlled by the production process, which is of great concern to production company[8].

The primary techniques for safeguarding meat are salting and drying and these techniques were used in the Mesopotamia civilization (Iraqi civilization)[9]. For the dried meat products, maintaining their quality is primarily achieved through moderating or complete hindrance or inactivation of pathogens, such as *E. coli* and *Salmonella*. *Salmonella* is another key cause of food-borne diseases in people. In excess of 99,000 instances of Salmonellosis were reported in the EU during 2010[10]. The USA and EU food safety regulations established no *Salmonella* can appear in 25 g of a prepared nourishment throughout the time span of its usability[11]. The primary goal for improving the shelf-stability of meat bars is to favor desirable microorganisms over undesirable microorganisms, while maintaining a consumer satisfaction with the product[8].

The sugars or carbohydrates were added to the meat products as restoring and drying agents. Dextrose, cane sugar (sucrose), brown sugar, etc. have been utilized as components in dry meat preparation. These supplements were also included to improve the flavor, to reduce the impact of the salinity and to reduce the water activity[8]. In present study, sugar derived from date palm was utilized.

The wrapping system is essential for chemical and microbial shelf-stability. The essential objective for the various wrapping systems is to ensure consumer safty and different wrapping techniques can prompts result in distinctive attributes for similar products. Vacuum wrapping is a common kind of decreased oxygen (O_2) wrapping[12]. Because most dried meats are shelf-stable in termes of the stability of their nutrients little attention is paid to wrapping. The correct wrapping prevents potential mold development and product oxidation that is undesirable organoleptically. Typically, products are wrapped under vacuum or under oxygen-free conditions[8].

The goal of the present study was to assess the sensory qualities and shelf stability of multicomponent meat products subjected to high temperature storage conditions.

MATERIALS AND METHODS

Determination of multicomponent meat: The multicomponent meat-based product was produced from halal beef, dried dates, walnuts and other nonmeat components. Cutting and extrusion were used to produce rectangular bars with 156 ppm $NaNO_2$ (ingoing), pH of 5.0 (encapsulated citric acid) and a water activity of 0.85. The meat bars were cooked at 70°C and chilled at 2°C before wrapping. The products were either set on a Styrofoam plate and wrapped with an oxygen porous film (a major packaging method in developing countries) or vacuum packaged and subjected to 25 or 50°C for 1, 7, 14 and 28 days. The meat bars were then assessed using various tests. Following 28 days of storage on a Styrofoam plate covered by an oxygen porous film, mold had developed; thus vacuum wrapping is a helpful

for packaging and storage (8 and 11 months) at room temperature and it can allow storage times of 8 months (at temperature of approximately 42°C) and 11 months (at temperature of approximately 52°C).

Sensory evaluation: The meat bars' sensory qualities (following 8 and 11 months of storage at room temperature) were assessed via a prepared board comprising 10 judges chosen from staff members of the department. The parameters of flavor, hardness, overall appearance and overall acceptability were scored on a 7-point hedonic scale from 7 = excellent to 1 = unacceptable[13]. The panel evaluations were held early in the day and the meat bars were served on plates to the specialist and progressively assessed in every session. The samples, which were sliced were served at room temperature.

Microbial analysis: The microbial status of the samples was assessed (following 8 and 11 months of storage at room temperature) by determining the total viable count (TVC), *Salmonella* and *E. coli*, which were measured utilizing a BacTrac 4000 Microbiological Impedance Analyser (SY-LAB Gerate GmbH, 3011 NeuPurkersdorf, Austria).

RESULTS AND DISCUSSION

Figure 1 demonstrates the results of the sensory evaluation of the multicomponent meat product and storage time had a significant effects ($p \leq 0.05$) on the sensory properties (flavor and overall acceptability). As per the specialists, samples stored for 8 months were acceptable ($p \leq 0.05$) in flavor, hardness, overall appearance and overall acceptance with scores of 6.7, 4.6, 5.8 and 6.7, respectively. The samples stored for 11 months were close to being unacceptable, because the flavor had decreased ($p \leq 0.05$) in value 3.4 to approximately 3 on the hedonic scale. Therefore,

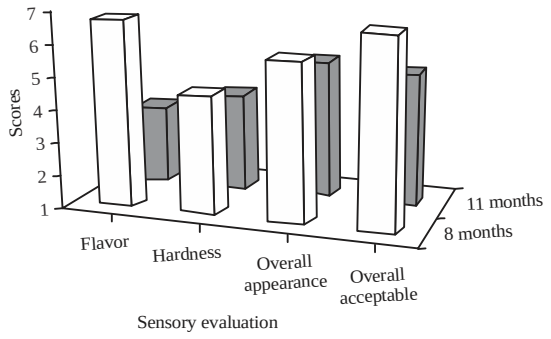

Fig.1: The effect of storage time at room temperature on the sensory parameters (mean value) of the multicomponent meat product

the overall acceptance of the samples that were stored for 11 months at room temperature had a lower ($p \leq 0.05$) score (5.1) than that of the samples stored for 8 months (6.7). In addition, when the overall acceptance score was below 3 the product was considered unacceptable and when such scores were acquired, the reason must be determined[14].

Based on the results of this examination, the temperature has a significant ($p \leq 0.05$) effect on the flavor changes during storage (the acceptability of the flavor decreases). Some authors conclude that the wrapping method impacts meat products more than the storage temperature[15,16].

There were no significant differences among hardness and overall appearance due to storage time. Others have concluded that sensory characteristics do not change linearly with increasing storage temperatures[17,18].

The increase in hardness was thought to be due to protein cross-linking, aggregation and network formation[16]. Others have confirmed that bar hardening during storage is due to the reduced surface hydrophobicity of the protein particles and the more ordered protein secondary structure[19,1],which would indicate that moisture relocation is the main cause of the hardening of the protein bars, yet the source and the endpoint of migration were note determined[1]. Zhou *et al.*[20] suggested that hardening occurred because of thiol-disulfide interchange reactions during storage.

In general, the sensory parameters (flavor, hardness, overall appearance and overall acceptance) decreased ($p \leq 0.05$) during storage from 8-11 months. Therefor, this new product can be stored for 8 months with no impact on the overall acceptance.

Table 1 indicates that the mean value of the total viable count (TVC) by the storage for one month was 9.9 CFU g^{-1} (Fig. 2) and it increased to 2.6×10^3 following 8 months (Fig. 3). After 11 months the TVC reached 3.9×10^4 (Fig. 4). These results were considered a great indicator of product legitimacy, as these values are consistent with the Iraqi microbial limits for food[21].

Likewise, neither *Salmonella* (Fig. 5 and 6) nor *E. coli* (Fig. 7 and 8) were observed in the meat bar products following storage at room temperature for 8 and 11 months,

Table 1: The effect of storage time at room temperature on the total viable count (TVC) (mean value) of multicomponent meat product

Treatment/storage months	TVC (CFU g^{-1})
1 month	9.9
	9.9
Means	9.9
8 months	1.1×10^3
	4.1×10^3
Means	2.6×10^3
11 months	5.9×10^4
	1.9×10^4
Means	3.9×10^4

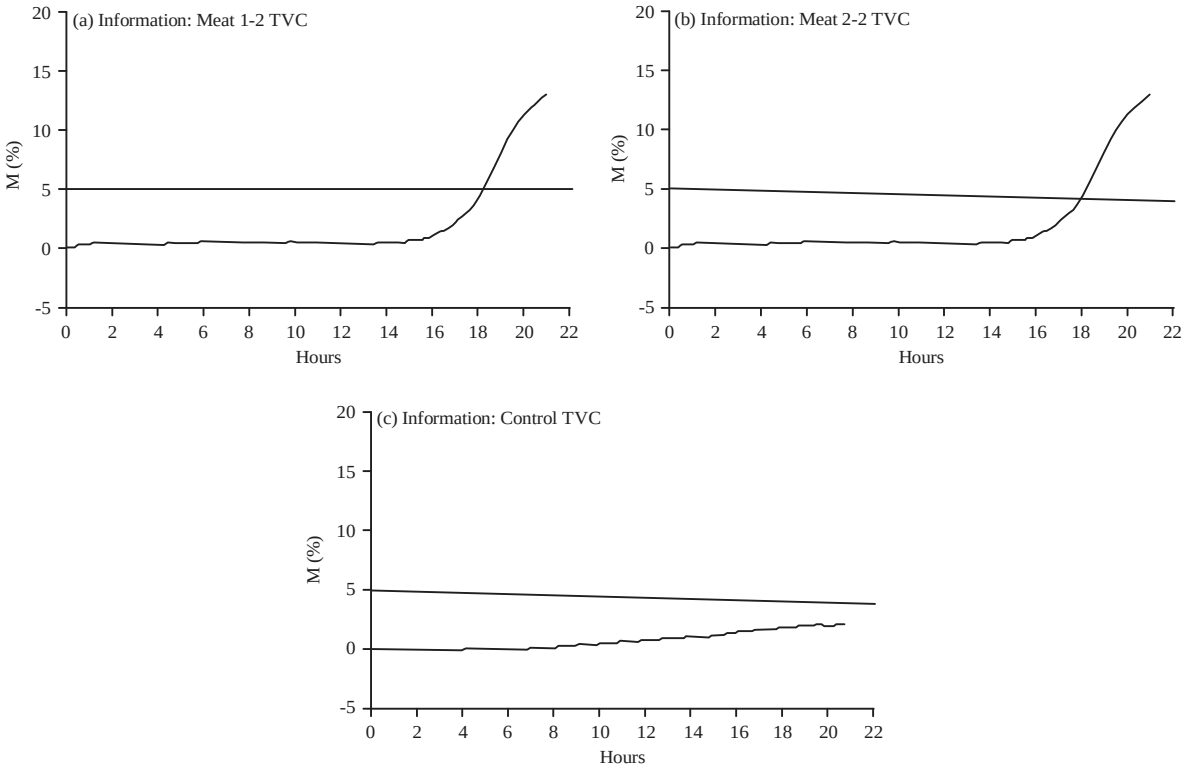

Fig. 2(a-c): The effect of storage time (1 month) at room temperature on the TVC (CFU g^{-1}) of the multicomponent meat product

M percentage: is the M value (detection for TVC)

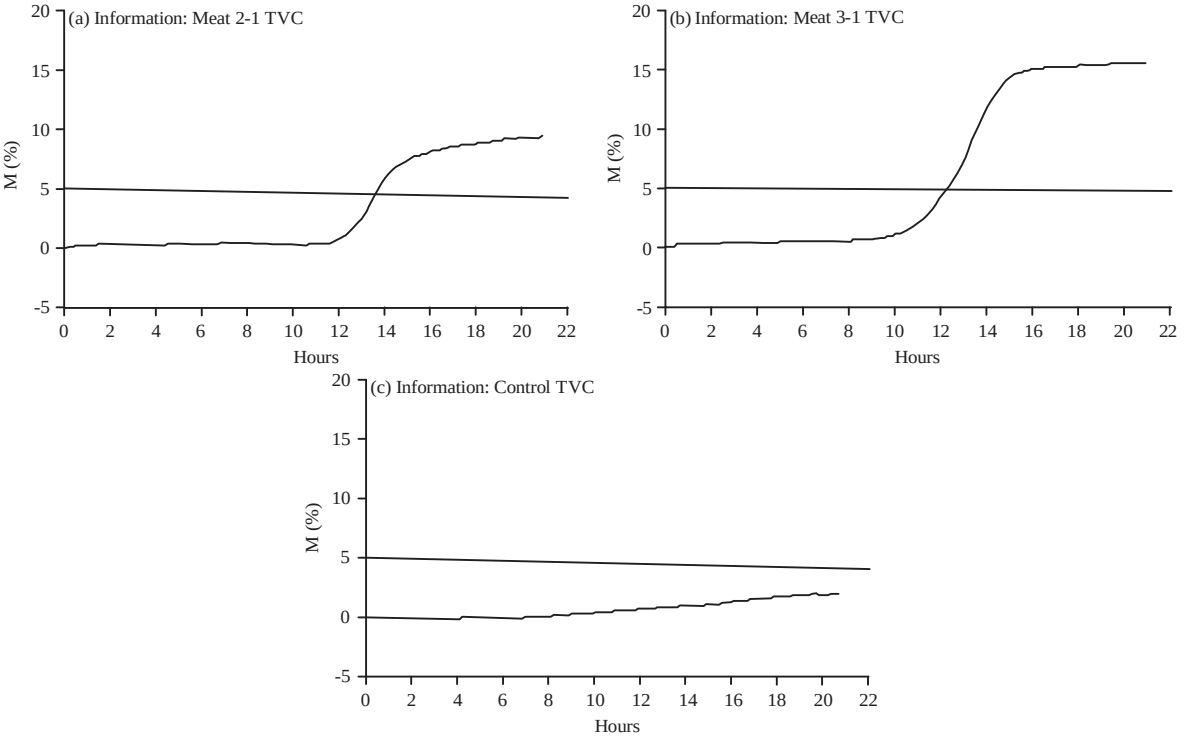

Fig.3(a-c): The effect of storage time (8 months) at room temperature on the TVC (CFU g^{-1}) of the multicomponent meat product

M percentage is the M value (detection for TVC)

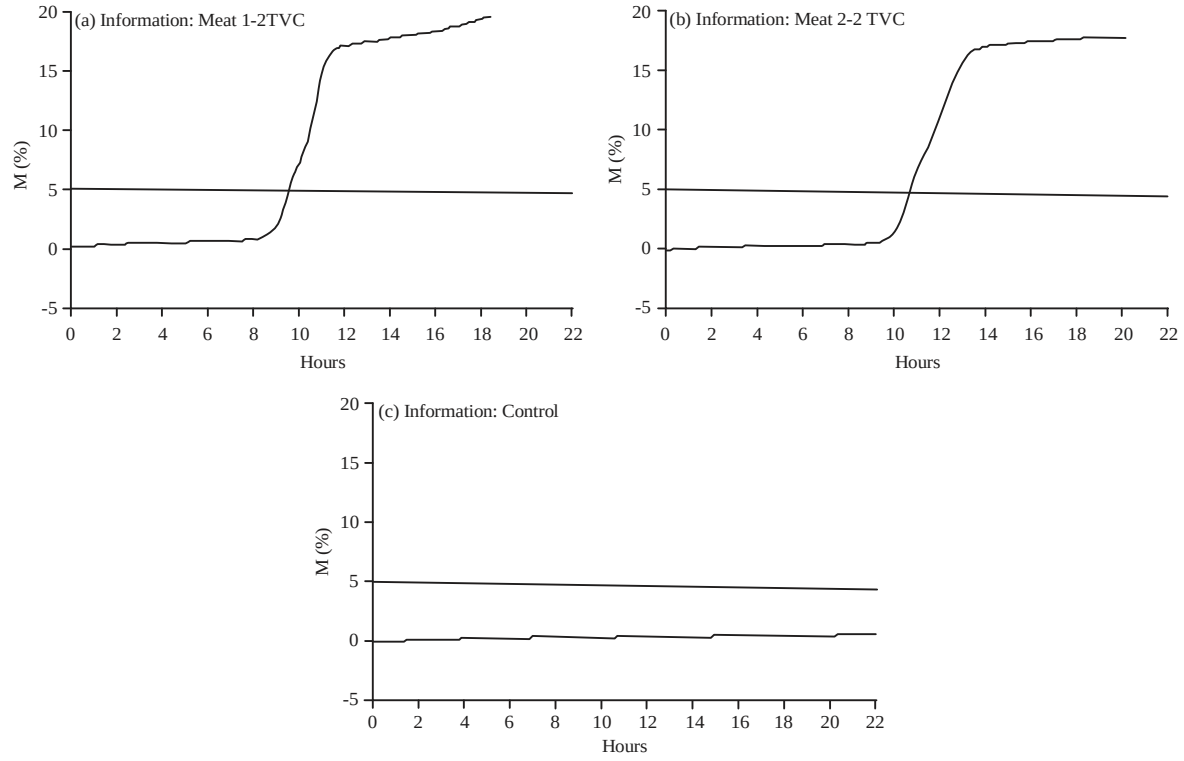

Fig. 4(a-c): The effect of storage time (11 months) at room temperature on the TVC (CFU g^{-1}) of the multicomponent meat product
M percentage is the M value (detection for TVC)

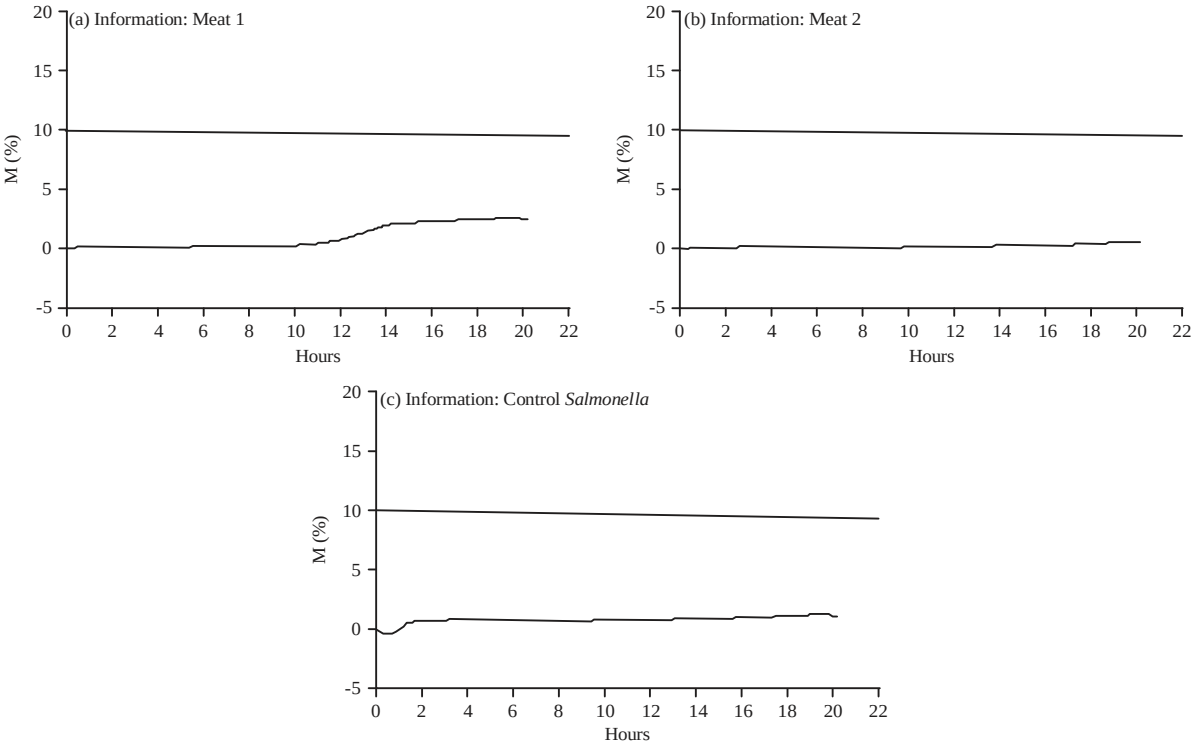

Fig. 5(a-c): The effect of storage time (8 months) at room temperature on *Salmonella* (CFU g^{-1}) in the multicomponent meat product
M percentage is the M value (detection for salmonella)

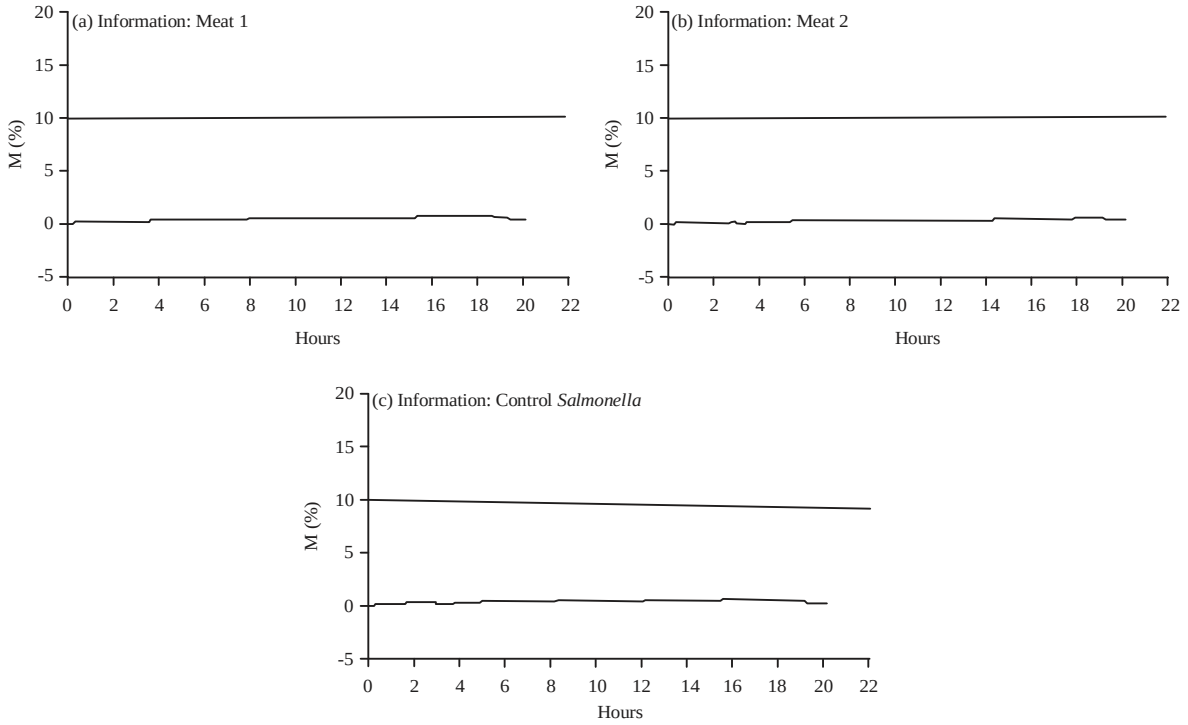

Fig. 6(a-c): The effect of storage time (11 months) at room temperature on *Salmonella* (CFU g^{-1}) in the multicomponent meat product

M percentage is the M value (detection for salmonella)

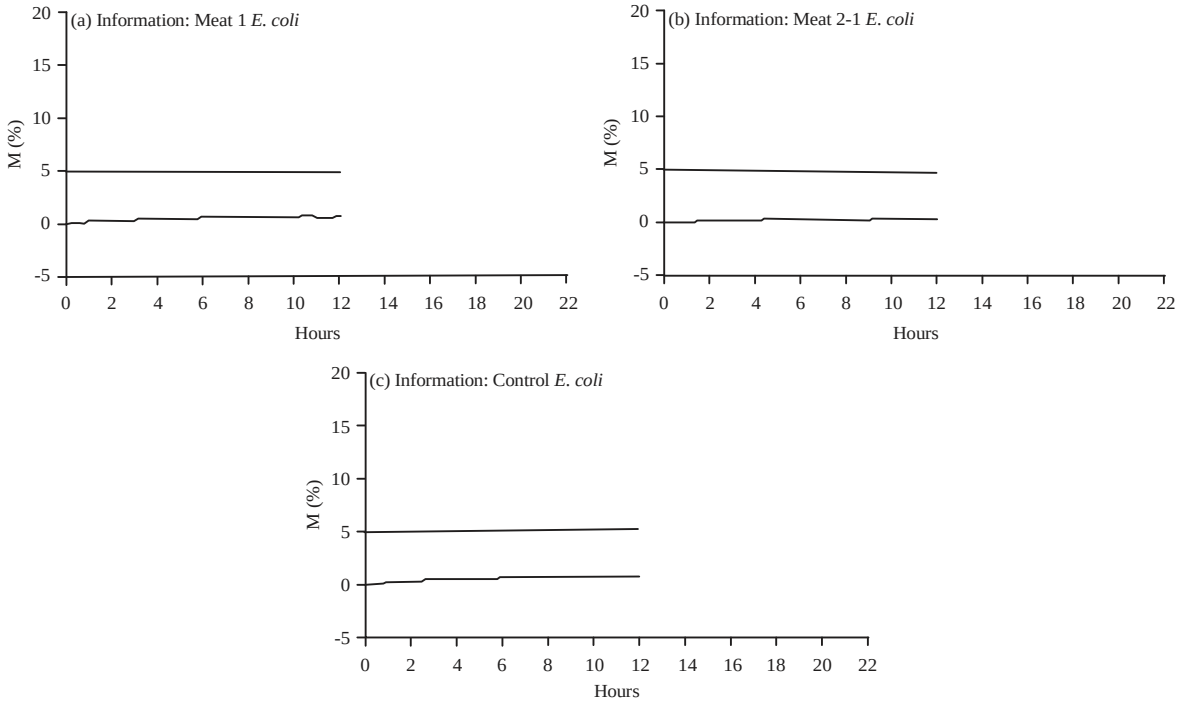

Fig. 7(a-c): The effect of storage time (8 months) at room temperature on *E. coli* (CFU g^{-1}) in the multicomponent meat product

M percentage is the M value (detection for *E. coli*)

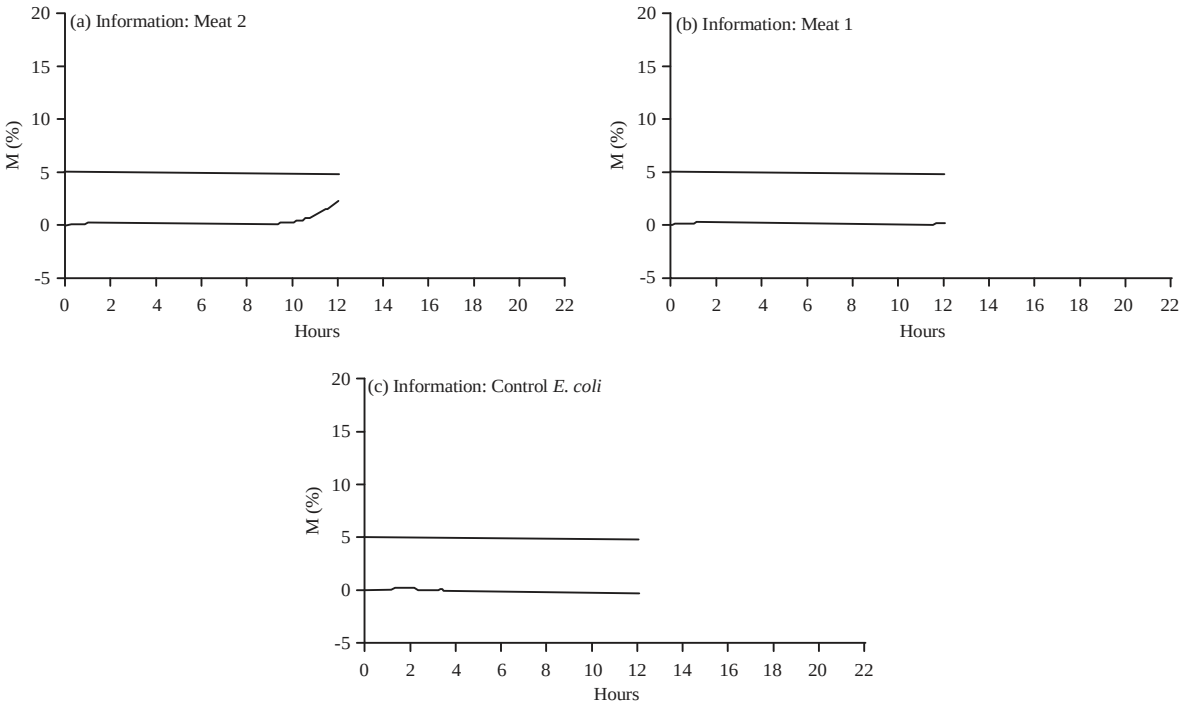

Fig. 8(a-c): The effect of storage time (11 months) at room temperature on *E. coli* (CFU g^{-1}) in the multicomponent meat product

M percentage is the M value (detection for *E. coli*)

which might be a direct result of the nitrate and nitrite that were added to the meat bars because of their essential roles in color and flavor improvement and their antioxidant activites[22].

Nitrite applies a significant antimicrobial impact identified with the inhibition of the development of a few pathogens, for example, Salmonella[23,24,11]. Also, the addition of cardamom as an additive to this product might delay the sullying due to its antimicrobial properties.

Additionally, due to the product being a dried meat, conducting acceptability examinations that confirm the absence of the development of relevant pathogenic microorganisms' would be of interest if the product is contaminated after the lethality step[8]. *Salmonella* is the main cause of food borne illnesses in people and more than 99,000 instances of salmonellosis were reported in 2010 in the EU[10,11]. The breaking point for Salmonella was 0.4 log CFU g^{-1} in dry fermented sausages[11].

The USA and EU food safety regulations established that no Salmonella can appear in 25g of dry fermented sausages throughout its shelf life[25,26].

The procedure for evaluating this material for high amounts of *Salmonella* and *E. coli* involved complete pulverization. Additionally, there was no development of similar microorganisms when the samples were treated at high levels of postlethality and stored at room temperature (the product appeared to be shelf stable)[8]. Overall, no security issues were observed in connection with microbial growth during storage for 8 and 11 months at room temperature.

CONCLUSION

The sensory evaluation and the shelf life of the multicomponent meat-based product suggest that 8 months of storage at 42°C is acceptable. During 11 months of storage the multicomponent meat-based product darkened and, lost moisture and the acceptability of its flavor decreased.

SIGNIFICANCE STATEMENT

This study found that vacuum wrapped multicomponent transitional moisture meat-based protein bars are safe and acceptable to consumers after 8 months of storage at room temperature (42-50°C) which may be beneficial for innovation of a new product (protein bars) for developing nations with nourishment security issues (lack of refrigeration). Thus, this study will help researchers develop other meat products that are suitable for countries with hot climates.

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