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The effect of adding *Malva Parviflora* leaves powder to improve quality and nutritive value of beef sausage at refrigerated storage

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Abstract

The study was conducted to discover the nutritional quality of *Malva parviflora* leaves powder (MPLP) thanks to its richness in protein and nutritious minerals. Moreover, MPLP was incorporated in the manufacture of beef sausage at different levels (0.5%, 1%, and 1.5%) to measure its effect on the most important quality criteria (chemical composition, physicochemical properties, and sensory properties) during 9 days of refrigeration storage. According to our knowledge this is the first time to incorporate the *Malva parviflora* as a potential functional ingredient in manufacturing healthier and cheaper beef sausages. Adding MPLP 1.5% has a positive effect on protein % (23.48%) compared with the control group (19,85). Despite this, the concentration of MPLP 1.5% significantly decreases the sensory proprieties regarding color and taste due to the presence of the greenish tint and the bitter taste. Whereas, in our study, we recommend the addition of a concentration of MPLP 0.5% since it has no negative effect on the physiochemical or sensory characteristics of beef sausage.

Keywords: *Malva parviflora*, beef sausage, physicochemical characters, sensory evaluation

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

Introduction

Plants have been a significant part of human nutrition since they are a major source of antioxidants, vitamins, and minerals. Due to their impact on life quality, vegetables and fruits must be consumed in increasing quantities in the modern diet (Elawa, 2015). The leafy vegetables take up a significant amount of space in the vegetable world. The nutrients found in leafy greens, such as proteins, dietary fibers, pigments, and vitamins, serve a variety of roles that are beneficial to health (Lincon *et al*., 2015).

Mallow (*Malva parviflora*) is an annual or perennial herb which is not farmed but rather collected in the wild or from areas near farmer's fields, waste ground, roadside, and desert. Mallow leaves are primarily consumed by rural Egyptians. (Massoudi *et al*., 2015). The Malvaceae family includes the genus, *Malva parviflora* is one of Egypt's most common species, growing in a variety of conditions ranging from highly damp to mid (Raheem et al., 2014). Chemical tests of *Malva parviflora* leaves revealed that the plant is rich in protein, carbohydrates, soluble fibers, phenols, terpenoids, coumarins, mucilage, and pigments. Its seeds also provide a sizable number of antioxidants (Salama *et al*., 2019).

Fresh sausage, uncooked smoked sausage, cooked smoked sausage, cooked sausage, dry and semi-dry sausages are the five major types of sausages. (Boyle, 1994). One of the most popular meat products in the world, fresh sausage can help with fresh meat shortage issues because it is affordable, delectable, and simple to cook. Sausages are processed meat products made from a mixture of minced or comminuted meat and fatty tissues combined with a variety of non-meat ingredients and additives (salt, herbs, spices, etc.) that are stuffed into casings, most commonly natural casings from the intestine to be formed into discrete units. Fresh sausages are offered without heat treatment and are usually refrigerated and sold chilled or frozen (Dinstel, 2014).

Sausages are a frequent and popular product that is made from lower-value trimmed meat to create a higher-value product. Moreover, thanks to its simple procedure and easily obtainable ingredients, it is produced in butcher shops, meat processing plants, even at home (Sirini *et al*,.2022).

The purpose of this research was to study the effect of various concentrations of powdered *Malva parviflora* leaves on the physicochemical, proximate analysis, and sensory evaluation of beef sausage.

Materials and Methods:

plant collection and preparation:

From November 2022 to March 2023, fresh plant material *(Malva parviflora* leaves) was harvested at the agricultural farmlands in South Valley University, Qena, Egypt. The plant material was identified according to standard taxonomic keys in Botany Department, Faculty of Science, South Valley University, Qena, Egypt.

The leaves were cleaned, washed to remove any mud or debris, dried in a hot air oven at 40 ˚C for one to two days, sieved through mesh screens, then processed into a fine powder using a blender, and finally stored in glass bottles at room temperature until needed.

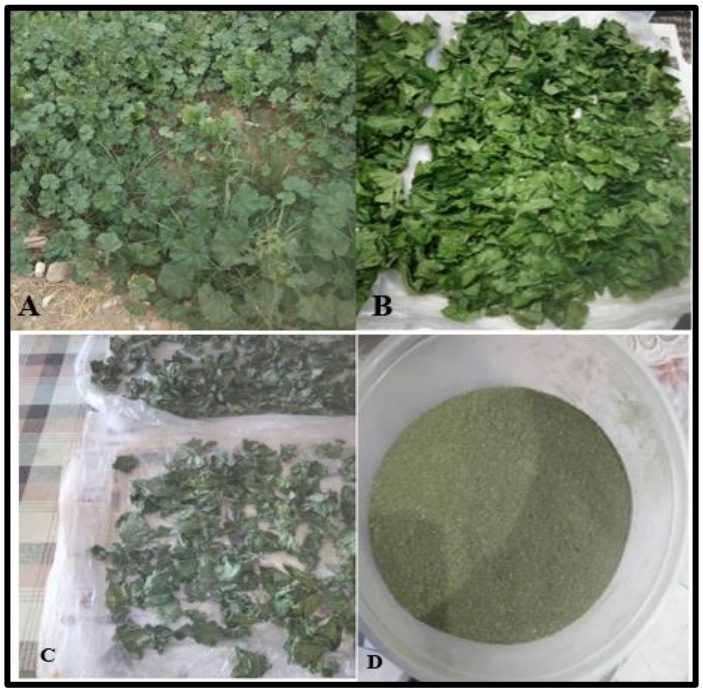

Fig. 1: plant collection and preparation: (A) plant in the farmland, (B) Cleaning and washing of plant, (C) drying of plant, (D) grinding of plant to be fine powder.

Sausage manufacturing

Preparation of beef sausage samples

Fresh beef meat and beef fat were purchased from a local market in Qena and transferred to the lab of the Department of Food Hygiene and Control, Faculty of Veterinary Medicine, South Valley University, Qena, Egypt. Both beef meat and beef fat were minced separately. As shown in (Fig.1). The beef sausage was divided into 4 groups (each one was stuffed in natural mutton casing) to prepare the experimental treatments (Table 1 and Table 2). Then, the control group and all treated groups samples were packed in polyethylene bags at refrigerator temperature (4°C). During refrigerated storage, the control and treated samples were periodically analyzed in days (0,3,6,9) for sensory, pH, and proximate analysis. The fresh oriental sausage was processed according to the criteria recommended by the Egyptian Organization for Standardization and Quality Control (EOS., 2005).

Table 1. List of the treatments

Treatments	The concentration of *Malva parviflora* leaves powder
Control	Control without the addition of *Malva parviflora* leaf powder
T1	*Malva parviflora* leaf powder (MPLP) .5%
T2	*Malva parviflora* leaf powder (MPLP) 1%
T3	*Malva parviflora* leaf powder (MPLP) 1.5%

Table 2. Composition of various beef sausage treatments

Treatments	Ingredients						
	Meat	Fat	Iced water	Starch	Salt	Spices	*Malva parviflora* powder
Control	260	80	40	8	6	6	-
T1	260	80	40	8	6	6	2
T2	260	80	40	8	6	6	4
T3	260	80	40	8	6	6	6

Chemical examination of plant material in its raw state

Association of Official Analytical Chemists (AOAC, 2016) was used to assess the amount of moisture, protein, and ash in the material. The difference in weight of each constituent was used to determine the carbohydrate content.

Assessment of quality aspects of the formulated beef sausage:

Sensory Evaluation

The samples were coded with three-digit random numbers, then were evaluated using a 9-point hedonic scale for taste, color, odor, and texture by seven staff members from different departments, Faculty of Veterinary Medicine, South Valley University, Qena, Egypt. Organoleptic testing of the beef sausage was conducted in accordance with the guidelines provided by the American Meat Science Association (AMSA,1995). Water and bread were used to clean the mouth between sausage samples.

Fig. 2. Final product of manufactured beef sausage: (A) control group (beef sausage without addition of MPLP), (B) treated groups (T1 beef sausage contain 0.5 % MPLP, T2 BEEF sausage contains 1% MPLP and T3 beef sausage contain 1.5 % MPLP

Fig. 3. Sensory evaluation of manufactured beef sausage: (A) grilling of beef sausage, (B) measurement of the temperature of beef sausage during grilling until the temperature in the core reaches above 75°C, (C) preparation of samples of grilled beef sausage for sensory evaluation.

pH measurements

pH was measured by placing pH probe Ionizer digital, 701 A, Orion Research Inc. U.S.A. into sausage samples directly. Calibration was conducted at room temperature using phosphate buffers of pH 4.0 and 7.0.

proximate analysis:

Determination of moisture, protein, and ash content is determined according to Association of Official Analytical Chemists (AOAC, 2016). The carbohydrate value was obtained by subtracting the percentages of all other components such as moisture, protein, fat, and ash.

Statistical Analysis

The whole process was replicated two times. Each replication was performed on a different manufacturing day and each sample was analyzed in duplicate. The results were expressed as the means ±standard error of the mean. Two-way Analysis of Variance (ANOVA) Dunnett's multiple comparisons test was used for multiple comparisons at $p < 0.05$ level for significant differences between the samples using GraphPad 8.4.3 (686) for Windows software.

Results

Chemical Composition of raw plant material

The chemical composition of *Malva parviflora* leaves powders is listed in (Table 3) mainly moisture, protein, fat, ash, and total carbohydrates. It could be concluded that. *Malva parviflora* leaves powder contained a high amount of crude protein, which was found to be 37 .20± 0.41.

Table 3. Chemical composition of Malva parviflora leaves powder

parameters	Mean value ± SE
Protein %	37.20 ± 0.41
Fat %	4.36 ± 0.10
Moisture %	77.65 ±0.11
Ash %	12.72 ± 0.12
CHO %	45.71 ±0.36

Proximate analysis of manufactured beef sausage Determination of moisture, protein, and ash content is determined according to AOAC Official Method (AOAC, 2016).

Table 4. Statistical analytical results of proximate analysis of manufactured beef sausage

Treatments	Parameters				
	Protein %	Fat %	Moisture %	Ash %	CHO
Control	19.85±0.84	17.38±1.21	59.61±1.22	1.27±0.14	1.89±0.20
T1	20.77±0.87	16.85±0.98	59.42±1.00	1.32±0.15	1.65±0.23
T2	21.38±1.79	17.04±1.56	58.46±1.12	1.41±0.30	1.72±0.27
T3	23.48±1.67*	16.26±1.62	57.24±1.35	1.68±0.35	1.32±0.24

The moisture, ash, fat, and carbohydrate content did not present significant. differences ($p > .05$) between the control sample and the treated samples with *Malva parviflora* leaves powder. Only the protein content showed a slight increase ($p < 0.05$) in (MPLP 1.5%) with respect to the control sample. This rise in protein content may be attributed to the increasing concentration of *Malva parviflora* leaves powder in T3.

The moisture, ash, fat, and carbohydrate content did not present significant. differences ($p > .05$) between the control sample and the treated samples

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Effect of *Malva parviflora* leaves powder on pH of manufactured beef sausage during refrigeration at 4 ± 1 ˚C.

The pH values of the sausage remained stable and ranged from 5.41–5.71 during the whole period of refrigerated storage. As shown in (Table 5). There was no significant change between the control and treated groups. all values within all groups were within the normal range of pH according to EOS, (2005).

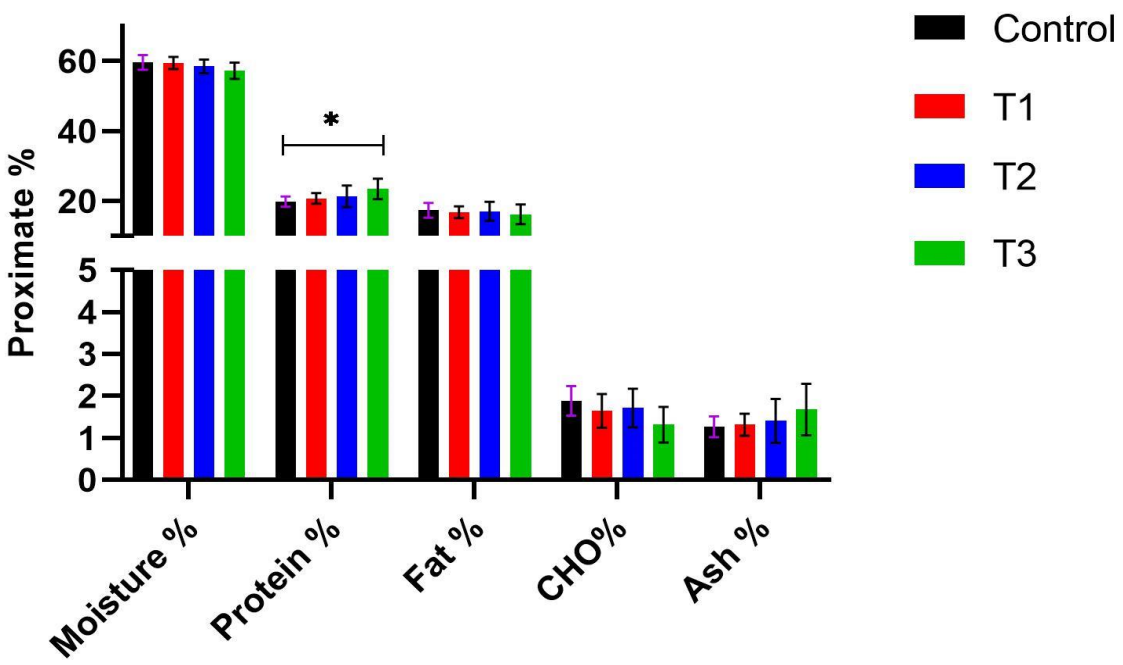

Fig. 4. Statistical analytical results of proximate analysis of manufactured beef sausage

Table 5. Statistical analytical results of pH values of various manufactured beef sausage during refrigeration at 4 ± 1 ˚C.

Treatments	days			
	0	3	6	9
Control	5.65 ±0.08	5.59 ±0.06	5.71 ±0.18	5.57 ±0.48
T1	5.58 ±0.23	5.51 ±0.13	5.66 ±0.23	5.50 ±0.31
T2	5.54 ±0.29	5.49 ±0.33	5.63 ±0.24	5.46 ±0.30
T3	5.51 ±0.38	5.41 ±0.32	5.61 ±0.29	5.42 ±0.32

Effect of *Malva parviflora* leaves powder on sensorial characters of manufactured beef sausage during refrigeration at 4 ± 1 ˚C.

Table 6. Statistical analytical results of sensory evaluation of various manufactured beef sausage during refrigeration at 4 ±1 ˚C.

Days	Sensory evaluation			
	Treatments			
	Control	T1	T2	T3
Color				
0	8.33±0.21	8.17±0.17	6.50 ±0.34**	6.00±0.52****
3	8.00±0.26	7.67±0.21	6.17±0.31**	5.17±0.40****
6	7.80±0.37	7.40±0.40	5.60±0.51***	4.40±0.40****
9	7.00 ±0.61	6.00±0.61	4.60±0.67***	4.20±0.22****
Odor				
0	8.17±0.17	7.67±0.21	6.83±0.17	6.00±0.37**
3	7.33±0.21	7.33±0.33	5.83±0.31*	5.33±0.42**
6	7.40±0.24	7.20±0.37	5.80±0.20*	5.00±0.32**
9	6.60± 0.91	5.20±0.55	4.80±0.82*	4.40±0.57**
Texture				
0	8.33±0.21	8.00±0.26	6.50±0.34*	6.17±0.54*
3	7.50±0.22	7.17±0.17	5.33±0.33**	5.00±0.37**
6	7.40±0.51	7.00±0.32	5.00±0.71**	4.40±0.60***
9	6.80±0.65	5.40±0.45	4.80±0.96*	4.20±0.74**
Taste				
0	8.17±0.17	8.00±0.26	7.33±0.42	6.50±0.43*
3	7.67±0.49	7.33±0.33	6.00±0.52*	5.00±0.52***
6	7.60±0.24	7.00±0.32	5.40±0.68**	4.80±0.37***
9	7.20±0.42	5.40±0.45*	4.40±0.67***	4.40±0.57***

The result was presented as mean ± standard error. Different star in the same column indicate significant differences ($P< 0.05$).

Discussion

First part: Chemical analysis of raw plant material:

As indicated in (Table 3) the moisture content was 77.65% in raw *Malva parviflora* leaves which agrees with (Abdalla *et al.*, 2016) who reported that the moisture % was 78.64 %. On the other hand, our results were lower than the results mentioned by (Ereifej *et al.*, 2015), (Abd Elhamid *et al.*, 2004) and (El-Tantawy ,2002) 93.8, 90 and 82%, respectively.

Furthermore, the protein % in raw *Malva parviflora* leaves in our study was 37.1% more than 31.01 and 22.9%, published by (Adeniyi *et al.*,2012) (Ereifej *et al.*, 2015), respectively. By contrast (Salama *et al.*, 2019) and (Abdalla *et al.*,

2016) described that the protein % was 39.13, and 44.77%, respectively.

Table 3 showed that crude fat content was 4.36 % which is higher than that reported by (Ereifej *et al.*,2015), (El-Tantawy, 2002), (Abdalla *et al.*, 2016) and (Mohammed *et al.*, 2023). Whereas lower than the results reported by (Abd Elhamid *et al*., 2004). That implies the important role of *Malva parviflora* on human health as it contains a high amount of protein and less amount of fat.

The Ash content of the raw leaves of *Malva parviflora* in this study was 12.72 % less than the result reported by (Abd Elhamid *et al*., 2004), (Barros *et al*., 2010), and (Ereifej *et al*., 2015). Another view is the results described by (Farhan *et al*., 2012), (Abdalla *et al*.,2016), and (Mohammed *et al*., 2023) 0.0871%, 10.47%, and 9.87 %, respectively. This confirms that *Malva parviflora* leaves are a good mineral source.

Finally, the carbohydrate content in our study was 45.71 % more than that declared by (Ereifej *et al.*, 2015) and (Salama *et al*., 2019). Conversely lower than (Mohammed *et al*., 2023) 52.4 %.

The deviation in the chemical contents of *Malva parviflora* in the previous studies from our study was probably due to the different geographical distribution, habitat, soil type, and temperature in which *Malva parviflora* is grown.

Proximate analysis and physicochemical properties of manufactured beef sausage

The crude protein, crude fat, moisture, ash, and carbohydrate % were 19.85, 17.38, 59.61, 1.27 and 1.89%, respectively for the control group. Owing to *Malva parviflora's* high protein content, the results indicated that T3 had a higher protein % than the control group by 6.83%. The results shown in (Fig. 4) showed that the protein content gradually increased as the level of *Malva parviflora* leaves powder increased from 0.5 to 1.5% in comparison to the control sample. All treated groups had lower moisture content than the control group. Less fat was present than in the control group. Ash content gradually rises in the treated groups as the amount of powdered *Malva parviflora* leaves increases; this is accounted for by the high mineral and vitamin content of the leaves of *Malva parviflora*.

This research is a first step towards a more profound understanding of the impact of *Malva parviflora* on the nutritive value and physicochemical and sensory evaluation of beef sausage. From my literature review, there is no data published about using *Malva parviflora* leaves powder in any meat products including beef sausage. A key strength of this research lies within the fact that *Malva parviflora* is free of cost.

As illustrated in (Table 4) The addition of the MPLP in beef sausage treated groups resulted in negligible changes in pH values when compared with the control group. These results are in line with (Liu *et al*., 2009), and (Singh *et al*., 2014) who stated that there were no significant differences in pH values between control and treated groups.

Results of the sensory evaluation of the sausage during the 9-days storage period are presented in (Fig. 3 and Table 6) A nine-point hedonic scale test was used in this study, with scores 1, 4, and 9, representing extremely dislike, neither like nor dislike, and extremely like, respectively. Based on the results, we made the following observations firstly, there were no significant differences between the control group and T1 (MPLP 0.5%) for color, odor,

texture, and taste during the whole period of storage.

Additionally, from day 0 until the end of the experiment there is high significance between the second and third groups in comparison with the control group in color due to the appearance of the greenish tint of *Malva parviflora* leaves powder as they contain a higher concentration of *Malva parviflora* leaves powder.

Eventually, it is important that the *Malva parviflora* flavor is not detected in the beef sausage because its flavor is related to very acidic or earthy flavors that sometimes are not acceptable by the consumer. Although some authors claimed that natural plant extracts or powder improved the sensory quality of sausages, the current findings suggest that the sensory quality of sausages depends on the type of plant, meat product, and natural component used.

Conclusion

The outcomes of our study lead to the conclusion that the use of *Malva parviflora* leaves powder at concentrations of 1.5% has proved to significantly increase the nutritive value especially protein % however affected negatively sensory characteristics especially color and taste. whereas the addition of *Malva parviflora* leaves powder in the concentration of 0.5% had no significant change on the sensory characteristics of beef sausage.

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