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Research Article

IMPACT OF EGYPTAIN DATE SEEDS POWDER AS A NOVEL TENDERIZING AGENT CAMEL MEAT PHYSICAL, TECHNOLOGICAL AND CHEMICAL PROPERTIES

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ABSTRACT

Camel meat is widely consumed in developing nations and is portrayed as a key source of nutritional supplements to meet human nutritional requirements while being healthier than other types of red meat. However, because of its rough texture and subpar organoleptic qualities, tough-aged camel meat is unpopular with customers. So, the objectives of this study were to use date seed powder as a tenderizing agent for camel meat to improve their physicochemical and sensory characteristics. The camel meat was marinated for 48 hours at 4±1°C with the two varieties of date seed powder at varying quantities (15 and 20g/200g meat). Physicochemical studies were conducted on both raw and cooked camel meat after tenderization. Sakkoti date seeds powder (ZDSP) and Samani date seeds powder (SDSP) improved the treated camel meats' moisture content, pH, water holding capacity (WHC) values, and solubility of collagen, sarcoplasmic, myofibrillar, and total proteins. Conversely, the treated sample's lower protein content, cooking loss values, and hardness as determined by texture profile analysis (TPA) when compared to the control. The color study revealed that all treated camel meat samples differed significantly ($p<0.05$) in terms of brightness, redness, and yellowness. The redness of the meat samples rose with the amount of powdered date seeds added. Given that the roughness of the meat decreased in all treated samples, it can be inferred that marinating camel meat with ZDSP and SDSP can tenderize the flesh; 20 g/200 g of meat was the optimal quantity of SDSP for this purpose.

1.Introduction

It is anticipated that there will be a rise in demand for premium meat, namely red meat (Mullen et al., 2017). Consumers' preference for meat is mostly determined by eating quality (Thorslund et al., 2016). According to El-Badawi (2018), the daily consumption of animal protein per capita in Egypt is 18.9 g, which is less than the minimum daily intake of 29.3 g recommended by Millward (2012). In contrast to other animals, camels can live in harsh conditions and produce huge amounts of meat for very little money in feed. It is useful source of meat in regions where the efficiency

of other animals' production is negatively impacted by the climate (Ashour and Abdel-Rahman, 2022).

Traditionally, aged males and females raised more for milk, racing, and transportation than for meat production are the main sources of camel meat. Egypt produces 23500 tons of meat annually from camels. This represents about 8 percent of the country's total meat production, or 275,300 tons annually (CAPMS, 2018). Camels are generally considered successful meat producers.

The reason for this is that they may adjust their eating habits with the seasons and reap the benefits of high-fiber diets. Demand for camel meat is strong even in communities where camels are not bred for inclusion in processed meat products. Because of its low fat content, high moisture content, relatively high polyunsaturated fatty acid content, high-quality protein rich in key amino acids, low cholesterol, and high vitamin content especially vitamin B complex, camel meat is considered a healthy diet for humans (Suliman, 2023). However, the harshness of camel meat and some undesirable flavors are among its most important defects and problems. Especially for those who eat it infrequently. Since almost all old camels are slaughtered, the issue of age may be the reason behind the unacceptable toughness of camel meat (Kurtu, 2004). Meat firmness can be divided into two categories: background firmness, which comes from connective tissue, and actomyosin firmness, which comes from changes in myofibrillar proteins. The structure of elastin and collagen also has a significant impact on the texture of meat. Juiciness, taste, and tenderness are the three main factors that influence how pleasing meat is to the senses (Aaslyng and Meinert, 2017 ; Grunert et al., 2004). Tenderizing meat involves breaking down long muscle fibers and softening the collagen until it becomes gelatinous. This soft gelatin will seep into the meat, giving it the moisture and tenderness it needs to be succulent. There are several ways to tenderize meat, chemically or physically, with the main goal being to lower the quantity of identifiable connective tissue while avoiding a significant breakdown of myofibrillar proteins. One popular approach to tenderizing meat is to treat it with proteolytic enzymes. A little result about tenderizing meat with plant powders is provided. According to Elbanna et al. (2015) , Egypt is the first significant country in the world's production, producing 1400072 and 175012 tons of dates and date seeds, respectively. The seeds exhibited between 6 and 15 percent of the ripe date's weight, depending on the variety and grade quality (Nehdi et al., 2010). Saturated and unsaturated fatty acids, minerals, crude fiber, total phenols, and carbohydrates are among the several chemical constituents found in date seeds (Ardekani et al., 2010). Date pit varieties are suitable for processing and eating because of their low levels of anti-nutritional components (Zahoor et al., 2011). One of the phenolic chemicals and antioxidants found in date seeds is tannin, which is found in significant concentrations in these seeds (Ghnimi et al., 2017; Rastegar et al., 2012). Meat collagen can be preserved from oxidation by tannins, as collagen plays a major role in the texture and tenderness of meat (Sieniawska, 2015). Historically, date seeds were used to tenderize meat (Weston et al.,2002), However, there is a paucity of scientific research supporting these methods. Therefore, the aim of this study was to evaluate the effect of these treatments on the physical and chemical properties of camel meat, as well as the effect of adding Sakkoti and Samani date seed powder (ZDSP) to camel meat.

2. Materials and methods

2.1. Date seeds powder preparation

The dates (Sakkoti and Samany) were purchased at the Kafr El-shiekh city local market in the Kafr El-shiekh governorate, Egypt. Direct separation existed between the date seeds. After rinsing them with water to get rid of any sticky date meat, they were air-roasted for two days at 50°C. Using a heavy-duty grinder, the dried date seeds were crushed

into a powder (100 mesh) (Essa and Elsebaie, 2022).

2.2. Preparation of camel meat pieces

Aged camel meat was sourced from local slaughterhouses in Kafr El-Sheikh Governorate, Egypt. Immediately after slaughter, the meat was packed in low-density polyethylene bags and refrigerated at 4 ± 1°C for 24 hours. Following the cooling period, the muscles were removed from refrigeration and cut into uniform pieces, approximately 3 cm^3 in size and weighing 200 grams, sliced along the direction of the muscle fibers. The meat samples were then divided into six treatment groups for experimental processing as follows:

C (Control): Untreated camel meat (0 g of date seed powder)

PA: Camel meat treated with 2 mL of 2% papain solution

ZDSP1: Camel meat marinated with 15 g of Sakkoti date seed powder

ZDSP2: Camel meat marinated with 20 g of Sakkoti date seed powder

SDSP1: Camel meat marinated with 15 g of Samani date seed powder

SDSP2: Camel meat marinated with 20 g of Samani date seed powder

2.3. Camel meat marinating

To make sure every piece of camel meat was completely covered; each treatment was weighed and combined with the marinade inside the plastic bag. After marinating, the meats were wrapped in polyethylene film and kept for 48 hours at 4±1°C (Ismail et al., 2018).The camel meat pieces were marinated for 48 hours, then drained and cooked for 20 minutes at 180°C in an oven, with an internal temperature probe thermometer reading of 75±1°C(Abdeldaiem et al., 2014).

2.4. Determining the chemical composition

Following marinating, the chemical composition of camel meat was ascertained using the procedures described in AOAC (2010)

2.5. Determining pH

After marinating, the pH value was measured using the procedures outlined in the AOAC (2010). By homogenizing a 1 gram sample of camel flesh with 10 milliliters of distilled water for 30 seconds, the pH was measured. Next, a pH-meter (Jenway 3510, UK) was used to test the pH at 25ºC.

2.6. Water holding capacity

Shalaby et al. (2018) presented a technique for assessing the water holding capacity (WHC) of marinated camel meat as a sign of tenderness using a filter paper press. The results were given in cm2/0.3 gm.

2.7. Determination of cooking loss (%)

According to Essa and Elsebaie (2018) the cooking loss was computed as the weight difference between individual raw and cooked camel meat sample.

2.8. Measuring the analysis of the texture profile

Every cooked, marinated camel's flesh was divided into equal-sized cubes measuring 2 by 2 centimeters on each side. Using a 75 mm-diameter compression platen (P/75) that was pushed to compress 75% of the sample height in two cycles of compression testing, a 25-kg load cell was used to perform the texture analysis. With a 5 mm penetration distance and a 5-second rest interval in between each cycle, the test conditions began with a pre-test speed of 5.0 mm/s, a test speed of 1.0 mm/s, and a post-test speed of 8.0 mm/s. A trigger force of 1.0 N was used. The examination was conducted three times, and the outcomes were documented (Eom et al., 2015).

2.9. The process of determining color

According to what Elsebaie et al. (2022) have previously indicated, the Hunter Lab Colorimeter device (Colorflex, Broomfield, CO, USA) was used to quantify the cooked marinated camel meat's yellowness (b*), redness (a*), and lightness (L*) objectively.

2.10. Collagen content

Using the method of Abdeldaiem et al. (2014), collagen content is dependent upon the hydroxyproline content and solubility of camel flesh samples. 40 ml of 6N HCl was used to hydrolyze two-gram camel meat samples for eighteen hours. After filtering the hydrolysate, distilled water was added to get the level down to 50 ml. For the estimate of hydroxyproline, an aliquot was utilized. A standard graph was used to calculate the hydroxyproline content after the absorbance was measured at 540 nm. The collagen content was measured in milligrams per gram of tissue and was computed by multiplying by 7.14.

2.11. Collagen Solubility

The technique outlined by Lin and Kuan (2010) was used to determine the solubility of collagen. Five grams of muscle tissue were placed in a 250 ml beaker and covered with a Petri dish before being immersed in a water bath. Next, heat the water bath to boiling and keep it for 30 minutes. After the meat is cooked, it is removed from the beaker, cut into small pieces, and mixed for 2 minutes at a temperature of 4±1°C using 50 ml of distilled water. Next, the extract was centrifuged for 30 min at 1500 g. Soluble hydroxyproline was quantitated in aliquots of cooked juice and centrifuged for eighteen hours. The formula used to determine collagen solubility was as follow:

$$\text{Coolagen solubility} = 7.14 \times \%\ \text{soluble hydroxyproline} \quad (1)$$

2.12. Sarcoplasmic, myofibrillar and total protein solubility

Total protein solubility and scoplasmic protein solubility were measured using the technique described via Joo et al. (1999). The differential in the solubility of total and sarcoplasmic proteins allowed for the determination of myofibrillar protein concentrations. The unit of measurement for total protein solubility was mg of protein/gm of sample. The differential in the solubility of total and sarcoplasmic proteins allowed protein solubility was mg of protein/gm of sample.

2.13. Statistical Analysis

The one-way variance statistical analysis followed by Duncan's tests was done via SPSS10 software and the data were reported as means± SD (SPSS, 2000).

3.Results and discussions

3.1. Chemical composition

The results in Table 1 showed the chemical composition of different pieces of camel meat marinated with different concentrations of Sakkoti or Samani date pit powder. The chemical composition of untreated (control) and glue-treated camel meat samples was 74.53, 75.31% moisture, 21.48, 20.86% protein, 2.66, 2.61% fat, 1.25, 1.15% ash,and 0.08, 0.07% carbohydrates, respectively. These values were consistent with Kadim et al. (2013) which showed that the chemical composition of camel meat from six muscles ranged from 1.9 to 6.2% fat, 0.85 to 1.5% ash, 17.1 to 22.1% protein, and 63.0 to 77.7% moisture. In contrast, the chemical composition of camel meat samples treated with Sakkoti date seed powder was as follows: for ZDSP1 and ZDSP2, respectively, 74.70, 74.98% moisture; 21.13, 21.02% protein; 2.65, 2.63% fat; 1.21, 1.18% ash; and 0.31, 0.19% carbohydrates. The chemical composition of camel meat samples treated with quail date seed powder was also mentioned in the same table, where the values of SDSP1 and SDSP2 were 74.86, 75.14% moisture, 21.06, 20.98% protein, 2.64, 2.62% fat, 1.20, 1.17% ash,and 0.24, 0.09% carbohydrates, respectively. There were no appreciable variations in the chemical composition of camel meat between ZDSP1 and SDSP1, or between SDSP2 and samples treated with papain, as indicated by table (1). When camel meat was marinated with Sakkoti or Samany date seed powder, camel meat's protein, fat, and ash content generally decreased while its moisture and carbohydrate content increased. This action was further

enhanced by the quantity of date seed powder used. These outcomes were consistent with those attained by Abdeldaiem et al. (2014). Furthermore, the chemical composition of camel flesh responded better to the application of Samany date seed powder treatment than it did to the application of Sakkoti date seed powder treatment. This outcome might be attributed to the high phenolic content of Samany date seed powder.

Table 1. Chemical composition of camel meat marinated with different amounts of Sakkoti or Samany date seeds powder

Sample	Amount of date seed powder used (g)/200g meat	Moisture	Protein	Fat	Ash	Carbohydrates
Control	-	74.53^{b}	21.48^{a}	2.66^{a}	1.25^{a}	0.08^{b}
Papain	2	75.31^{a}	20.86^{b}	2.61^{a}	1.15^{a}	0.07^{b}
ZDSP1	15	74.70^{b}	21.13^{a}	2.65^{a}	1.21^{a}	0.31^{a}
ZDSP2	20	74.98^{a}	21.02^{a}	2.63^{a}	1.18^{a}	0.19^{b}
SDSP1	15	74.86^{ab}	21.06^{a}	2.64^{a}	1.20^{a}	0.24^{a}
SDSP2	20	75.14^{a}	20.98^{ab}	2.62^{a}	1.17^{a}	0.09^{b}

Mean followed by different letters in the same column differs significantly ($P \leq 0.05$).

Additionally, data in the same table indicated that, as a result of treatment with papain, ZDSP1, ZDSP2, SDSP1 and SDSP2, respectively, the increase rate in moisture content of raw treated camel flesh was 1.05, 0.23, 0.60, 0.44, and 0.82%. All things considered, camel meat treated with papain, ZDSP2, and SDSP2 had considerably greater moisture content ($p \leq 0.05$) than the control. Conversely, no noteworthy differences ($p \leq 0.05$) were noted between ZDSP1, SDSP1, and Control. Meat samples treated with ZDSP1 had the lowest moisture percentage of marinated camel meat samples (74.70%).

The findings indicate that when the amount of powdered date seeds added increased, the meat's moisture content rose ($p \leq 0.05$). Similar results were also seen by Ismail et al. (2018), who discovered that the concentration of extracts from Ziziphus jujube (red dates), Camellia sinensis (black tea), and Aleurites moluccana (candlenuts) increased the moisture content of camel flesh.

The improved hydrophilic qualities of meat may be the reason for the higher moisture content in cured camel meat (Singh and Sit, 2022). Moreover, the high moisture content of cured meat was affected by the ability of the meat to bind a large amount of water (Wu et al., 2014). Increasing moisture content is crucial because it demonstrates the release of less water from meat, which increases the juiciness of meat products (Lawrie and Ledward, 2014). Therefore, the ability to hold water greatly contributes to the juiciness of the meat.

3.2. pH value

The meat's pH has a significant impact on processing, which in turn affects the meat's quality, color, and shelf life (Simela, 2007). When the quantity of date seed powder was increased, the pH of the camel meat samples considerably dropped ($p \leq 0.05$) (Table 2). Camel meat marinated with papain produced the lowest pH of 5.33, whereas camel meat marinated with 20 g of Samany date seed powder produced the highest pH of 5.52. The pH of the camel flesh in the control sample, on the other hand, was 5.82, higher than the pH of any of the treatments.

Table 2. Effect of marinating with different amounts of Sakkoti or Samany date seeds powder on pH value, water holding capacity and cooking loss of camel meat

Sample	Amount of date seed powder used (g)/200g meat	Raw meat		Cooking loss
		pH value	WHC (cm^2/0.3gm)	
Control	-	5.82^{a}	2.68^{bc}	37.21^{a}
Papain	2	5.33^{d}	3.39^{a}	28.46^{cd}
ZDSP1	15	5.71^{a}	2.87^{b}	33.17^{b}
ZDSP2	20	5.58^{b}	3.11^{ab}	30.12^{c}
SDSP1	15	5.68^{b}	2.95^{b}	32.44^{b}
SDSP2	20	5.52^{c}	3.26^{a}	29.17^{c}

Mean followed by different letters in the same column differs significantly ($P \leq 0.05$).

The pH value of the treated sample dips between the fibrillation protein's dielectric points, possibly as a result of the glycolysis process, which turns glycogen into lactic acid (Nor et al., 2018). Soft tissue is the result of increased muscle fiber protein hydrolyzing into peptide bonds due to the increasing amount of date seed powder added to camel meat. The findings imply that date seed powder may hasten the process of glycolysis, which would hasten the decrease in meat's pH.

3.3. Water Holding Capacity (WHC)

One of the most important characteristics of meat is its water holding capacity (WHC), or the flesh's natural ability to hold onto water. The WHC of fresh meat is recognized to affect the technological quality of the meat processing (Maqsood et al., 2015).

When compared to samples of marinated camel meat, the data in Table (2) demonstrated that the control sample had a higher water holding capacity (i.e., lower values). WHC was higher in the camel meat marinated with 20 g Sakkoti date seed powder (3.11 cm2/0.3gm), 20 g Samany date seed powder (3.26 cm2/0.3gm), 15 g Sakkoti date seed powder (2.87 cm2/0.3gm), and 15 g Samany date seed powder (2.95 cm2/0.3gm) than in the camel meat control sample (2.68 cm2/0.3gm) (Table 2). These findings are consistent with those of Abdeldaiem et al. (2014), who observed an increase in WHC values of 5.50, 6.10, and 5.70 cm2/0.3gm for camel meat samples treated with 15, 30, and 45% doses of ginger extract, respectively. Increases in collagen and protein solubility may be the cause of this shift in WHC in the treated samples. Connective tissue-derived hydrolyzed collagen has a high capacity for binding water and can enhance the softness of cooked meats (Cho and Kim, 2019).

3.4. Cooking loss:

Additionally, Table 2 displays the decreasing value of cooking loss for date seed powder-marinated camel flesh. The reduction in meat weight that occurs while cooking is known as cooking loss (Vasanthi et al., 2007). pH affects the amount of cooking loss in meat; a lower pH results in more water retention capacity (Kadıoğlu et al., 2019). This study shows how cooking loss and date seed powder, a meat tenderizer, relate to one another. It was shown that as the quantity of powdered Sakkoti or Samany date seeds rose, the cooking loss decreased.

In comparison to the control, which had a cooking loss value of 37.21%, the camel meat marinated with 15 and 20 grams of powdered Sakkoti date seeds showed cooking loss values of 33.17% and 30.12%, respectively. In contrast to the 28.46% cooking loss value for camel meat marinated with papain, the cooking loss values for 15 g and 20 g of camel meat marinated with powdered Samany date seeds were 32.44% and 29.17%, respectively.

3.5. Texture profile analysis

One of the main things that draws customers to meat products is the texture of the flesh. Table 3 presents the impact of several dosages of Sakkoti or Samany date seed powder marinating on the textural attributes of camel meat, including its hardness, cohesion, springiness, and chewiness. With the exception of cohesiveness, control samples of camel meat had the highest values for each of the four major factors taken into consideration (Table 3).

Table 3. Effect of marinating with different amounts of Sakkoti or Samany date seeds powder on camel meat texture

Sample	Amount of date seed powder used (g)/200g meat	Hardness (N)	Springiness	Cohesiveness	Chewiness (N)
Control	-	322.8^{a}	0.64^{a}	0.61^{a}	146.36^{a}
Papain	2	198.13^{f}	0.51^{a}	0.72^{a}	117.80^{e}
ZDSP1	15	282.2^{b}	0.62^{a}	0.64^{a}	137.57^{b}
ZDSP2	20	229.1^{d}	0.58^{a}	0.67^{a}	130.11^{c}
SDSP1	15	271.3^{c}	0.59^{a}	0.66^{a}	132.83^{c}
SDSP2	20	217.6^{e}	0.55^{a}	0.69^{a}	126.41^{d}

Mean followed by different letters in the same column differs significantly ($P \leq 0.05$).

The values of hardness (322.8 N), springiness (0.64), cohesiveness (0.61), and chewiness (146.36 N) were recorded for the control sample of camel flesh. On the other hand, the camel meat samples treated with papain had the following characteristics: 198.13 N for hardness, 0.51, 0.72, and 117.80 N for cohesiveness, hardness, springiness, and chewiness. The four criteria taken into consideration for both the control and camel meat treated with papain samples demonstrated a substantial difference in the results.

The reduction of the meat samples' hardness, springiness, and chewiness indicates that as the amount of date seed powder used in the treatment grew, so did the flesh softness for both camel meat samples treated with Sakkoti or Samany date seed powder. Hardness is defined by Bourne (2002) as a product that exhibits a significant resistance to deformation or the "first bite" as observed by human sensory analysis. It is sometimes referred to as the compressive strength(Aguirre et al., 2018).

The texture analysis's hardness parameter revealed that the hardness of the camel flesh samples is significantly influenced ($p<0.05$) by the amount of Sakkoti or Samany date seed powder used. With the exception of samples treated with papain, camel meats marinated with 20 g of Samany date seed exhibited the lowest hardness value (217.6 N) among all the samples examined.

The amount of date pit powder added to marinated meat had an effect on the hardness of cooked camel meat samples, according to the results of the analysis of variance (ANOVA). Comparison of all samples with the control group, to which no Sakkoti or Samani date seed powder was added, revealed a decrease in hardness levels. Similar to previous research using red dates (*Ziziphus Jujube*), the texture and hardness of camel meat decreased as the amount of date pit powder used increased. Ismail et al. (2018) found that the hardness of cured meat gradually decreased as the concentration of plant extracts increased. Additionally, they stated that the measure of hardness is the most important, as tender meats have lower levels of hardness. According to Aguirre et al. (2018), Springiness (also referred to as elasticity) is the degree to which a sample returns to its initial shape after being compressed (Chandra and Shamasundar, 2015). Each feature contributes to the overall

acceptability and appeal of the food product, and is a great way to measure the strength of the protein matrix after heating. Both SDSP2 and ZDSP2 presented the lowest doneness value after cooking when the meat was marinated with 20 g of date seed powder. Camel meat marinated with 20 grams of Sakkoti or Samani date seed powder obtained an interquartile score of 0.58 and 0.55, respectively.

These results demonstrated the Sakkoti or Samany date seed powder's capacity to decrease stiffness and enhance meat softness. Additionally, data in the same Table demonstrated that for all treated samples, there were no ($p \leq 0.05$) significantly different cohesiveness and springiness characteristics when compared to the control.

The amount of chews needed to swallow food is referred to as chewiness (Aguirre et al., 2018). According to the findings, the chewiness value varied considerably ($p \leq 0.05$) for each treatment. The results showed that 20 g of date seed marinated may considerably ($p \leq 0.05$) lower both the chewiness versus the control and 15 g treatments. The chewiness value recorded for camel meat marinated with Sakkoti date seed powder was 130.11 N. On the other hand, the camel meat marinated with Samany date seed powder showed 126.41 N. According to certain research (Pathera et al., 2016; Sharima-Abdullah et al., 2018), the cohesiveness, gumminess, and chewiness of meat products are closely connected to their hardness.

3.6. Colour analysis

Table 4 displays the variations in the color of the camel meat. As the quantity of Sakkoti or Samany date seed powder rose, the L* values of camel flesh dramatically ($p \leq 0.05$) reduced.

Table 4. Effect of marinating with different amounts of Sakkoti or Samany date seeds powder on camel meat colour.

Sample	Amount of date seed powder used (g)/200g meat	*L**	*a**	*b**
Control	-	34.41^{a}	19.92^{f}	17.80^{b}
Papain	2	30.19^{d}	25.20^{a}	18.40^{a}
ZDSP1	15	33.95^{a}	21.34^{e}	17.91^{b}
ZDSP2	20	32.08^{b}	22.87^{c}	18.13^{a}
SDSP1	15	33.75^{a}	21.82^{d}	17.98^{b}
SDSP2	20	31.54^{c}	23.65^{b}	18.27^{a}

Mean followed by different letters in the same column differs significantly ($P \leq 0.05$).

The L* values for the papain-treated camel meat and the control camel meat were 30.19 and 34.41, respectively. Nonetheless, it was discovered that, with values of 33.95 and 33.75, respectively, the L* value declining for camel meat did not differ statistically between ZDSP1 and SDSP1 samples. In contrast to the control sample, which had a L* value of 34.41, the samples treated with date seed powder showed the lowest L* value, 31.54, from the SDSP2 treatment. The decreased L* value suggested that the camel meat's color did indeed shift to a deeper shade. This was in line with the redness or the growing value in a*. When compared to the control, the treated samples' redness (a) value rose considerably ($p<0.05$). As the quantity of powdered date seeds increased, the redness (a) of the camel flesh samples steadily rose. Those treated with papain had the highest overall redness (a), followed by those treated with ZDSP2 and SDSP2. There was no discernible difference in yellowness (b) between the control, SDSP1, and ZDSP1. The papain-treated camel meat sample had the maximum yellowness (18.40), followed by the SDSP2 and ZDSP2 samples. There was no

noticeable difference in yellowness (b) between control, SDSP1, and ZDSP1. The camel meat sample treated with glue was the yellowest (18.40), followed by SDSP2 and ZDSP2 samples. There was an increase in the degrees of yellowing of different camel meat samples with an increase in the percentage of date seed powder used. The phenomenon of color change may be due to the denaturation of myoglobin that occurs at high temperatures.

Table 5. Effect of marinating with different amounts of Sakkoti or Samany date seeds powder on camel meat colour

sample	Amount of date seed powder used (g)/200g meat	Collagen content (mg/gm)	Collagen solubility (%total collagen)	Sarcoplasmic protein solubility (mg/gm)	Myofibrillar protein solubility (mg/gm)	Total protein solubility (mg/gm)
Control	-	7.29^{c}	7.14^{e}	20.33^{d}	61.57^{f}	81.90^{e}
Papain	2	8.98^{a}	23.72^{a}	24.57^{a}	88.28^{a}	112.85^{a}
ZDSP1	15	7.48^{c}	10.53^{d}	21.20^{c}	69.44^{e}	90.64^{e}
ZDSP2	20	8.11^{b}	17.15^{b}	22.62^{b}	78.96^{c}	101.58^{c}
SDSP1	15	7.66^{c}	12.07^{c}	21.80^{c}	72.85^{d}	94.65^{d}
SDSP2	20	8.20^{b}	19.66^{b}	23.04^{a}	80.19^{b}	103.23^{b}

Mean followed by different letters in the same column differs significantly (P≤0.05).

According to Suman and Joseph (2013), the main factor affecting meat color in hema sarcoplasmic protein is myoglobin, which is chemically species-specific. According to Hughes et al. (2014) water loss occurred by cooking or aging may decrease the myofibrillar lattice space, fiber diameter, and osmolality, all of which can increase the meat's surface lightness. The outcome demonstrated that the temperature utilized while cooking was the reason behind the change in color of the meat.

3.7. Collagen content and collagen solubility of camel meat

Collagen, a major protein found in connective tissue, is thought to be the cause of the rough texture of meat. It is evident from Table (5) that the treated samples under consideration had somewhat greater collagen content than the control samples. Additionally, all treated samples showed considerably higher collagen solubility values when compared to the control. Those treated with papain had the greatest overall collagen content, followed by those treated with ZDSP2 and SDSP2.

Additionally, data in the same Table showed that all treated samples had considerably greater collagen solubility values than the control. The results of Singh and Singh (2020) were in line with the enhanced collagen solubility of the date seed powder-treated samples in our investigation. In addition, Shalaby et al. (2018) also found that camel meat treated with alkaline and acidic proteases had considerably increased collagen solubility when compared to the control sample.

3.8. The solubility of sarcoplasmic, myofibrillar, and total proteins in camel flesh

The breakdown of myofibrillar proteins was the cause of the alterations in protein solubility. According to Maqsood et al. (2015), protein solubility serves as an indication of protein denaturation, with poor protein solubility indicating a high degree of denaturation.

Table (5) illustrates how the powdered Sakkoti or Samany date seeds affect the solubility of sarcoplasmic, myofibrillar, and total protein in camel flesh.

The sarcoplasmic protein solubility values of the treated camel meat with Sakkoti and Samany date seed powder (15, 20 g/200 g meat) showed a little increase in the results,

recording (21.20, 22.62 mg/gm) and (21.80, 23.04 mg/gm), respectively, in comparison to the control (20.33 mg/gm). However, there was a significant increase in the solubility of both myofibrillar and total proteins, particularly in the SDSP2 and ZDSP2 samples, which had respective solubility values of 80.19 and 103.23 mg/gm and 78.96 and 101.58 mg/gm, as opposed to 61.57 and 81.90 mg/gm for the reference sample.

Sarcoplasmic, myofibrillar, and total protein solubility values were greatest in papain-treated samples overall; SDSP2 and ZDSP2 samples came in second and third. The earlier findings are consistent with the findings of Abdeldaiem et al. (2014) and Naveena et al. (2004).

4. Conclusions

The results of the study showed that the chemical and physical properties of camel meat were enhanced when soaked in ZDSP and SDSP. When date seed powders were applied to meat samples, the hardness of the samples decreased significantly. Reduced cooking loss, increased moisture content, improved texture, and a lower pH were all results of the marinating process. In general, the amount of date seed powder applied has a positive effect on the physical and chemical properties of camel meat. According to this study, ZDSP is not as effective as SDSP in tenderizing camel meat. Given that the majority of tests gave positive results, adding date seed powder to camel meat showed that it has a good index as a tenderizing agent. This result is consistent with the characteristics of the date seed, which contains a vital component that greatly affects the tenderness of the meat. It is recommended that more comprehensive research be conducted in the future to ascertain which bioactive components in date seeds are most responsible for meat tenderness and to consider the effects of date seed powder on different types of meat.

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