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FULL PAPER

Valorisation of date seed powder (*Phoenix dactylifera* L.) for tenderizing properties of different types of meat

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Abstract

Recently, date (*Phoenix dactylifera* L.) seeds have gained much popularity due to their vast applications that benefit people and the environment, elevated with plenty of research on food product formulation, cosmetics, and medicinal supplements. Date seeds constitute 10-15% of the date fruit weight. Although date seeds are considered waste products, however, they contain many valuable substances such as carbohydrates, oil, dietary fibre, protein, bio-active polyphenol, tannin and natural antioxidants. Thus, valorisation of the date seeds is necessary as the value could be utilized maximally if they are being studied aptly. This study was intended to (i) evaluate the physical properties of beef and lamb in terms of texture, pH, colour, cooking loss, and water holding capacity as affected by date seed powder; and (ii) compare the tendering effect of date seed powder towards beef and lamb. Texture profile analysis indicated significant differences ($p \leq 0.05$) in terms of hardness, springiness, chewiness, and gumminess between the different amount of seed powder used in marinated beef and lamb. The lowest pH value belonged to 20 g of date seed powder which was 5.7 and 6.2 for beef and lamb, respectively. The colour of the lamb was found to be significantly different in terms of lightness, redness, and yellowness when date seed powder was used regardless of its amount. Both beef and lamb displayed a statistically significant ($p \leq 0.05$) reduction of colour (L*, a*, and b*) from 20 g treatment samples with 29.7 and 26.5, respectively over the control samples. For beef, redness and yellowness demonstrated a significant difference ($p \leq 0.05$) for 20 g treatment samples marinated with date seed powder. Both cooking loss and water holding capacity (WHC) was reduced as the amount of date seed powder used was increased. Different amounts of date seed powder affected the physical properties of beef and lamb, while 15 g and 20 g of date seed powder showed a positive result in regards to meat tenderness.

1. Introduction

The date palm (*Phoenix dactylifera* L.) is one of the world's most cultivated palms. It is common in the Afro-Asian dry band, extending from North Africa to the Middle East (Riahi *et al*., 2009). The date palm is composed of a fleshy pericarp and seed has been an important crop in arid and semiarid regions of the world (Besbes *et al*., 2004). Date seeds are known as waste products of many food industries that are based on the technological processing of dates (Youssif and Alghamdi, 1999). Despite that, the date seeds are a good source of natural antioxidants (El-Rahman and Al-Mulhem, 2017; Tafti *et al*., 2017) that has the potential to become one of the waste-to-wealth technologies. However, few studies of date seeds were done; most studies focused on the chemical composition of the date seeds (Hamada *et al*., 2002). Date seeds contain a high level of tannin (Rastegar *et al.,* 2012, Ghnimi *et al*., 2016) which are the phenolic compounds and one of the antioxidants in date seeds. Tannin can prevent the oxidation of collagen in the meat (Sieniawska, 2015).

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Collagen is one of the key factors in meat tenderness and texture (Weston *et al*., 2002). According to Maqsood and Benjakul (2010), tannin also displayed a protective effect against lipid. Lipid is also a contributing factor in the tenderness and juiciness of meat (Amaral *et al*., 2018) and oxidation of lipid can diminish the meat tenderness. El-Rahman and Al-Mulhem (2017) reported that the antioxidant activity of date seeds is 81.85% and is considered a good source of natural antioxidants. In short, date seeds can prevent the oxidation of collagen and lipid in meat, preserving the tenderness of the meat. The consumption of meat is one of the most discussed topics in the food industry. In general, consumers are highly emphasized on the quality of meat products that they consumed (Guerrero *et al.*, 2013).

Commonly, date seed is widely used as additives for the animal diet, natural dietary fibre, coffee-substitute drink, and antioxidants (Brouk and Fishman, 2016). Moreover, based on several studies, it is believed that concentrated date seed can be used as a functional food ingredient and potentially be an inexpensive source of natural dietary fibre and antioxidants (Al-Farsi and Lee, 2008). Amany *et al.* (2012) investigated the effect of date seed phenolic compounds on lipid oxidation and quality of ground beef during refrigeration, and the result shows that it can reduce the formation of hydroperoxides during storage as it consists of the phenolic compounds. This indicates the new application of date seed is in line with the improvement in the food industry which is relatable with the meat sector.

Therefore, this study was performed to investigate the tenderizing effect of date seed powder on meats from the different types of ruminants which are beef and lamb as well as to evaluate other significant parameters including pH, colour, texture, cooking loss, and water holding capacity (WHC).

2. Materials and methods

2.1 Sample preparation

A total of 1000 g of dates were collected from the confectionery industries, and 150 g of date seeds with 10 -15% of date flesh were directly isolated and then hand-picked to eliminate the damaged ones. The selected seeds were soaked in water, then washed to remove any adhering date flesh, and finally oven-dried at 60°C for 72 hrs. The dried seeds were ground in a heavy-duty grinder to pass 1–2 mm screens which turned it into powder and then preserved in an airtight container at -20°C until analyses. The adult beef and lamb, on the other hand, were respectively obtained from the local supermarket in Jeli, Kelantan.

2.2 Treatments

The adult beef and lamb were separated from conjunctive tissue and the fat were cut into 2×2 cm pieces with a weight of 200 g for each beef and meat respectively and were cut along the muscular fibres. The meat pieces were then divided into three groups for different treatments. Each treatment series consisted of (B1) – pieces of beef with 0 g of date seed powder, (B2) – pieces of beef marinated with 15 g of date seed powder, (B3) – pieces of beef marinated with 20 g of date seed powder, (L1) – pieces of lamb with 0 g of date seed powder, (L2) – pieces of lamb marinated with 15 g of date seed powder, and (L3) – pieces of lamb marinated with 20 g of date seed powder.

Each of the beef and lamb was weighed and immersed in the marinade inside the plastic bag to ensure each meat was fully covered. The marinated meats were then covered with polyethylene film and stored at 4±1°C for 48 hrs (Maryana *et al.*, 2018). Then, all the marinated meats were cooked using a microwave oven set at a power 124 of 70 W and a frequency of 2450 MHz for 50 mins (Calkins and Sullivan, 2007).

2.3 Determination of texture profile analysis

Each of the cooked marinated beef and lamb was cut into cubes with equal sides of 2×2 cm. The texture analysis was performed using a 25 kg load cell, and a 75 mm diameter compression platen (P/75) which was forced to compress 75% of the sample height in two cycles of compression tests. The test conditions started with pretest speed at 5.0 mm/s, test speed at 1.0 mm/s, and post-test speed at 8.0 mm/s where the penetration distance was 5 mm and a rest period of 5 s between two cycles using a trigger force of 1.0 N. The test was repeated three times, and the results obtained were recorded (Eom *et al.*, 2015).

2.4 Determination of pH value

The pH determination of marinated beef and lamb were conducted before post-cooking treatment. In this method, the pH meter was used and tested at room temperature following the Almeida *et al*. (2013) procedure.

2.5 Determination of colour

The determination of colour for cooked marinated beef and lamb was examined for its lightness (L*), redness (a*), and yellowness (b*) attributes using a colourimeter.

2.6 Determination of kinetic value of cooking loss on

meat

According to Dall *et al*. (2003), the cooking loss was expressed as g/100 g by weight difference between uncooked and cooked samples. Cooking loss was then calculated as an average value using Equation (1) given by:

$$(\%)\ \text{Cooking Loss} = \frac{W_1 - W_2}{W_0} \times 100 \quad (1)$$

Where W_0 indicates the initial weight of the sample (before cooking), W_1 is the initial weight of the sample (before cooking), and W_2 represents the final weight of the sample (after cooking).

2.7 Determination of kinetic value of water holding capacity

The water holding capacity of each cooked marinated beef and lamb was determined using the drip loss method where weighted cooked meat was kept in a sealed container and left at 4°C for 48 hrs (Karakaya *et al*., 2006). Percentage of Drip Loss (WHC) was

$$\%\text{Drip Loss (WHC)} = \frac{\text{Weight of Ash}}{\text{Weight of Sample}} \times 100 \quad (2)$$

computed using Equation (2) given by:

2.8 Statistical analyses

All the experiments were performed in triplicate and the data were presented as means ± standard deviation. The probability value of $p<0.05$ indicated a statistically significant result. Analysis of variance (ANOVA) was performed and mean comparisons were measured via Tukey's test using Statistical Package for Social Science (SPSS) software.

3. Results and discussion

3.1 Texture profile analysis

The beef and lamb were subjected to texture profile analysis in determining the textural properties of cooked marinated meat. Texture profile analysis (TPA) is a useful tool that can assess the palatability of a meat product. There were four main characteristics were tested on the meat samples, namely hardness, springiness, gumminess, and chewiness. Both control samples of beef and lamb showed the highest value for each of the four main characteristics considered (Table 1). For the beef control sample, the value of hardness was 2073.6 g, springiness was 8.7 mm, gumminess was 1984.0 g, and chewiness was 171.1 mj. The hardness, springiness, gumminess, and chewiness for the lamb control sample, on the other hand, were 2068.5 g, 7.1 g, 1327.7 g, and 107.4 g respectively. The results showed a significant difference for the four characteristics considered for both beef and lamb samples. As the amount of date seed powder increased in the treatment, the meat tenderness for both beef and lamb samples also increased which can be proved by the decrease of hardness, springiness, gumminess and chewiness of the meat samples. According to Bourne (2002), hardness describes as a product that displays substantial resistance to deformation or the "first bite" that would be perceived by human sensory analysis. It is also known as the strength needed to compress a sample (Aguirre *et al*., 2018). The hardness parameter of texture analysis showed that different amounts of date seed powder have significant effects ($p<0.05$) on the hardness of the beef and lamb meats. Beef and lamb meats marinated with 20 g of date seed had the lowest value of hardness as compared to 15 g and control with 2021.9 g and 1982.3 g, respectively. The results of ANOVA indicated that the amount of date seed powder added to marinated meats affected the hardness of cooked beef and lamb. The hardness values decreased in all of the samples when compared to the control which was free from the date seed powder addition. The hardness texture of beef and lamb decreased as the amount of date seed powder used increased, matching the results of earlier conducted studies using red dates (*Ziziphus jujube)* by Ismail *et al*. (2018), as they reported that the hardness of treated meat decreased gradually as the concentration of plant extracts increased. They also stated that the hardness parameter is most significant, because the less the hardness, the softer the meats.

Table 1. Texture of beef and lamb meat marinated with different amounts of date seed powder.

Parameter	Type of meat used (g)					
	Beef			Lamb		
Amount of date seed powder used (g)	0	15	20	0	15	20
Hardness (g)	2073.6±0.85^a	2055.3±1.12^b	2021.9±1.21^c	2068.5±0.72^a	2011.8±0.92^b	1982.3±1.36^c
Springiness (mm)	8.7±0.01^a	6.0±0.01^b	3.6±0.01^c	7.1±0.02^a	5.3±0.01^b	3.5±0.02^c
Gumminess (g)	1984.0±2.00^a	1384.7±1.53^c	1610.0±1.00^b	1327.7±2.08^c	1494.0±2.00^b	1569.3±1.53^a
Chewiness (mj)	171.1±1.25^a	82.53±1.06^b	57.3±0.92^c	107.4±1.45^a	74.9±1.11^b	45.8±0.81^c

Values are presented as mean±SD, n = 3. Values with different superscript within the row are significantly different ($p≤0.05$).

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Springiness is to what extent the sample comes back in its original form after being compressed (Aguirre *et al*., 2018) and is also known as elasticity (Chandra and Shamasundar, 2015). All attributes contribute to the overall desirability and acceptance of the food product as well as an excellent measure in studying the strength of the protein matrix formed during heating. Based on the treatments using 20 g of date seed powder to marinate the meat, both beef and lamb gave the lowest value for springiness after being cooked. The springiness values for 20 g date seed marinated beef and lamb were 3.6 mm, and 3.5 mm, respectively. These values showed the ability of the date seed to reduce the elasticity and thus increase the meat tenderness.

Gumminess is defined as the product of hardness and cohesiveness (Chandra and Shamasundar, 2015). Cooked beef and lamb marinated with 20 g of date seed powder had the lowest and significantly different ($p<0.05$) gumminess value compared to 15 g of date seed powder. The value for gumminess of 20 g date seed marinated beef and lamb were 1610.0 g, and 1569.3 g, respectively. Meanwhile, the gumminess value for 15 g date seed powder marinated beef was 1384.7 g, whereas lamb was recorded as 1494.0 g. In this case, the amount of date seed powder added has significantly affected the gumminess of the final cooked marinated beef and lamb.

Chewiness refers to the number of chews required for the swallowing of food (Aguirre *et al*., 2018). Based on the results, all treatments gave a significantly different ($p<0.05$) value for chewiness. The chewiness value observed for beef was 57.3 mj, while for lamb 45.8 mj revealed that 20 g of date seed marinated can significantly ($p<0.05$) reduce both the chewiness against control and 15 g treatments. It is suggested that the texture properties such as cohesiveness, gumminess, and chewiness have been directly correlated to the hardness of meat products (Pathera *et al.*, 2016; Sharima-Abdullah *et al.*, 2018). The increasing pattern shown by the values of gumminess from both beef and lamb meat samples is aligned with the findings of previous studies by Pathera *et al.* (2016), and Sharima-Abdullah *et al.* (2018).

3.2 pH Value

The pH of the meat plays important role in processing which will affect its shelf life, colour, and quality of meat (Simela, 2005). The pH for both beef and lamb were significantly decreased ($p\leq0.05$) when the amount of date seed powder increased (Table 2). The lowest pH of 5.7 and 6.2 was generated by beef and lamb marinated with 20 g of date seed powder, respectively. In comparison, the pH for both beef and lamb without date seed powder (control sample) were 5.9 and 6.5 respectively, which were higher than that of treatments with date seed powder. The decrease of pH in the treated sample may be due to the glycolysis process where the glycogen is converted into lactic acid; hence the pH value falls between the dielectric points of fibrillation protein (Maryana *et al.*, 2018). The increasing amount of date seed powder added into the beef and lamb have prompted more protein from muscle fibres hydrolyzed into peptide bond, resulting in soft tissue. Based on the result, it is suggested that date seed powder could accelerate the glycolysis process, therefore accelerating the decline of the pH of meat.

Table 2. pH of beef and lamb meat marinated with different amounts of date seed powder.

Amount of date seed powder (g)	Type of meat (g)	
	Beef	Lamb
0	5.95±0.02^{c}	6.52±0.02^{c}
15	5.85±0.02^{b}	6.35±0.02^{b}
20	5.67±0.03^{a}	6.15±0.01^{a}

Values are presented as mean±SD, n = 3. Values with different superscript within the column are significantly different ($p\leq0.05$).

3.3 Colour value

The colour of all cooked marinated beef and lamb was expressed in terms of L*, a*, and b* which indicates lightness, redness, and yellowness respectively. The colour of both beef and lamb are affected by several factors such as the meat pigment (myoglobin) prior to and during cooking, pH, modified atmosphere packaging, rapid thawing, low-fat content, nitrite, and irradiation (King and Whyte, 2006). According to Kondjoyan *et al.* (2013), the Maillard reaction is the process of meat browning that occurs with the presence of heat. During the reaction, amino acid and glucose inside the meat will combine and react together causing the meat to become darker in colour.

The changes in the colour of the meat can be seen in Table 3. L* values of both beef and lamb were significantly ($p\leq0.05$) decreased as the amount of date seed powder increased. The L* values for both control beef and lamb were 34.5 and 28.2, respectively. However, it was found that the L* value decreasing pattern for beef was not significantly different between 15 g and 20 g treatments with values of 30.7 and 29.7, respectively. Meanwhile, the lowest L* value was generated from the 20 g treatment of lamb with 26.5 as opposed to control with 28.2. The decreasing pattern in L* value implied that the colour of the meat does change to a darker colour. This was aligned with the increasing value in a*, which represents the redness. The beef displayed a significantly ($p\leq0.05$) increased value where 20 g date seed powder recorded the highest value with 10.90±0.38 in comparison with the control beef with 8.4,

Table 3. Colour of beef and lamb meat marinated with different amounts of date seed powder.

Parameter	Type of meat (g)					
	Beef			Lamb		
	Amount of date seed powder (g)					
	0	15	20	0	15	20
L*	34.5±0.98[a]	30.7±0.85[b]	29.7±0.79[b]	28.2±1.15[b]	27.4±0.82[c]	26.5±0.68[a]
a*	8.4±0.10[b]	8.8±0.13[b]	10.9±0.38[a]	12.7±0.30[a]	11.6±0.30[b]	10.2±0.23[c]
b*	16.6±0.09[b]	16.3±0.18[b]	17.4±0.23[a]	17.3±0.22[a]	15.7±0.11[b]	15.2±0.09[c]

Values are presented as mean±SD, n = 3. Values with different superscript within the row are significantly different ($p \leq 0.05$).

the lowest. The converse was true for lamb in which a* value was decreasing significantly ($p \leq 0.05$) for each treatment as opposed to the control. The highest a* value belonged to the control lamb with 12.7; while 20 g date, seed powder had the lowest with 10.2.

The occurrence of colour changes when the temperature increases as a consequence of myoglobin denaturation. Myoglobin is the main cause of meat colour in the sarcoplasmic hema protein and is species-specific chemically (Suman and Joseph, 2013). Colour changes from red to pink occur at 60-700ºC (140-1580ºF) and from pink to grey – light tan occurs at 70-800ºC (158 - 1760ºF) (Kondjoyan *et al.*, 2013). Water loss induced by cooking or during ageing could reduce the myofibrillar lattice space, fibre diameter, and impact the osmolality, contributing to an increase in the lightness of the meat surface (Hughes *et al.,* 2014). Based on the result, it showed that the changing of meat colour was caused by the temperature used during cooking.

3.4 Kinetic value of cooking loss

Figure 1 shows the decreasing value of cooking loss for both beef and lamb marinated with date seed powder. Cooking loss is the decrease in beef's weight during the cooking process (Vasanthi *et al*., 2006). Cooking loss in the meat is influenced by pH, whereby the lowest value of pH leads to higher water retention capacity (Dall *et al.*, 2003). The relationship of date seed powder as a meat tenderizer with cooking loss can be seen in this study. It showed that the value of the cooking loss decreased as the amount of date seed powder increased. The cooking loss value for lamb marinated with 15 g and 20 g date seed powder were 21.8%, and 19.8%, respectively, compared to the control lamb which was 25.1%. Meanwhile, the cooking loss value for 15 g and 20 g date seed powder marinated beef was 27.7%, and 25.8%, respectively, when compared with 30.0% for control beef.

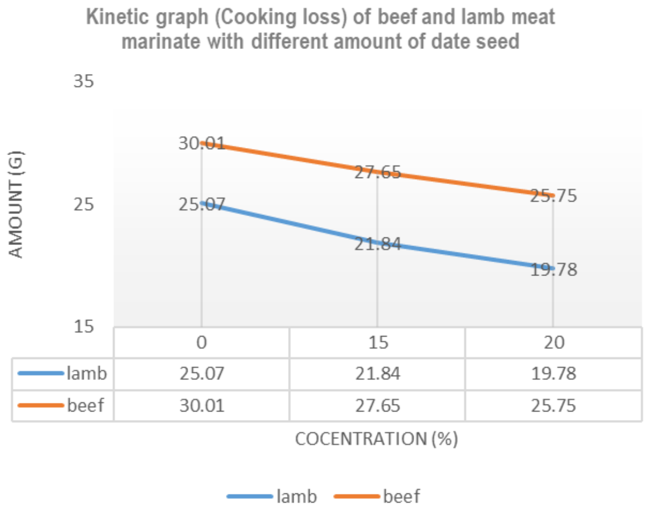

Figure 1. Cooking loss of beef and lamb meat marinated with different amounts of a date seed.

3.5 Water Holding Capacity (WHC)

Fluid loss can be partly explained by the decreased binding of water by the protein. The mechanism by which drip is lost from meat is influenced by both the pH of the tissue and the amount of space in the muscle cells, particularly the myofibril that exists for water to reside. Since myofibrils occupy about 80% of the volume of living muscle fibres, it is generally accepted that most of the water in the muscle cell is present in the myofibrils, in the spaces between the thick and thin filaments. Dripping refers to the loss of beef fluid and the evaporation of water due to the reduction in muscle protein (actin and myosin) (Yu *et al*., 2005). This fluid in extracellular space may be the source of drip, with decreasing pH of the meat protein, the lower their ability to bind water, thus contributing to the total fluid loss. Smulders and Laack (1991), suggested that an increase in protein denaturation may cause higher drip loss. The decrease in pH combined with a relatively high temperature at room conditions results in the denaturation of myosin. Thus, the loss of functionality of proteins is reduced, decreasing the drip loss in cooked marinated meat. As expected, the WHC of the cooked marinated beef of 20 g date seed powder (83.1%), and cooked marinated beef of 15 g of date seed powder (85.1%) were lower than that of the control sample of beef (96.0%). The same trend was observed from the WHC of the cooked marinated lamb of 20 g date seed powder (80.1%), and cooked marinated lamb of 15 g of date seed powder (82.1%), both were lower as compared to the control sample of lamb (94.1%) (Table 4). WHC varies greatly among the muscles of the body and animal

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species. According to Heinz and Hautzinger (2007), both beef and lamb have the greatest capacity to retain water, followed by pork, with poultry having the least such as chicken.

Table 4. Water holding capacity (WHC) of beef and lamb meat marinated with different amount of date seed.

Amount of date seed powder (g)	Type of meat (g)	
	Beef	Lamb
0	5.95±0.02[c]	6.52±0.02[c]
15	5.85±0.02[b]	6.35±0.02[b]
20	5.67±0.03[a]	6.15±0.01[a]

Values are presented as mean±SD, n = 3. Values with different superscript within the column are significantly different (p≤0.05).

4. Conclusion

In conclusion, tenderizing the beef and lamb with date seed powder showed a significant improvement regarding its quality. All the treatments proved to increase the tenderness of both types of meat in comparison to the control samples. However, cooking loss and water holding capacity (WHC) for both cooked beef and lamb are inversely proportional to the amount of date seed powder applied; both cooking loss and WHC reduced as the amount of date seed powder used was increased. Beef marinated with date seed power had a lower cooking loss than the marinated lamb. The result from the addition of date seed powder into meat products showed that it has a good indicator as a tenderizing agent since most of the tests indicated positive results. This finding complies with the property of date seed which consists of a bioactive compound that has a significant effect on meat tenderness. It is recommended for future studies to conduct a comprehensive study to determine which bio-active compounds in date seeds contribute more to meat tenderness and also to investigate the effects of date seed powder on another type of meat such as white meat or poultry.

Conflict of interest

The authors declare no conflict of interest.

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