



Chemical Composition of Ekhlas Date Seed Pits and its Water Extract Potential Impact on Body Weight Gain and Health Profiles of Ardi Goat Kids during Suckling Period

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ABSTRACT

Background: Date pit extract has been shown to significantly effect on body health and functions.

Methods: Twenty Ardi goat kids (Body weight 9.47 kg $\pm$ 0.92) were distributed over two groups; control and date pits water extract groups. Chemical composition of date pits seeds including organic and inorganic components in addition to total phenols were determined. Body weights gain, physiological parameters, hematological and biochemical profiles were recorded.

Result: The results showed that date pit contains 3.23% total phenols, 7.29% protein, 9.85% crude fiber, 28.38% total carbohydrates and 0.49% ash. In addition, the mineral contents (mg/kg) of Ekhlas date seeds show 11700 nitrogen, 2039.64 phosphorus, 1015 potassium, 9.026 copper, 238.33 iron, 462.34 magnesium, 10.6 manganese, 11.12 zinc, 0.31 lead and 0.026 cadmium. Date pits groups had higher ($P < 0.05$) final body weight (g) and rectal temperature if compared to control group. Pulse rate and SPO2 values were not differed between date pits and control groups. Additionally, red and white blood cells, packed cell volume and total protein values were increased of date pit group compared to control one. Besides, liver, kidney and muscle functions in addition to iron and copper values were improved in date pit group if compared to control one. On the other hand, urea and creatinine values were decreased ($P < 0.05$) due to water extract date pit consumption compared to control one. It could be concluded that seven percent of water extract date pit consumption improved body weight, physiological, hematological and biochemical profiles in growing Ardi goat kids.

Key words: Biochemical, Body weight, Date pit, Hematological, Phenol, Physiological.

INTRODUCTION

The date palm is an ancient plant that humans have been growing for a very long time, since about 4000 B.C. It's a unique plant because it has separate male and female trees and it's classified as a monocot in the Arecaceae family (Al-Mahmoud *et al.*, 2012; Farag 2016; Costa *et al.*, 2018). The date palm (*Phoenix dactylifera* L.) holds significant economic and cultural importance across arid and semi-arid regions globally, leading to the high-volume production of dates (Al-Karmadi and Okoh 2024; Al-Habsi 2025). As a result of processing the fruit for human consumption, a substantial amount of lignocellulosic waste is generated, primarily in the form of date seed pits, which constitute between 10 and 18% of the fruit's total weight (Shi *et al.*, 2023; Mohammed *et al.*, 2025a). The disposal or underutilization of this agricultural byproduct presents a significant environmental challenge and represents a lost opportunity for resource valorization (Capanoglu *et al.*, 2022; Liu *et al.*, 2023).

In parallel, livestock production systems, particularly those involving small ruminants like goats, face ongoing pressure from rising conventional feed costs (Paolino *et al.*, 2025). Consequently, research efforts are increasingly focused on identifying sustainable, locally available agro-industrial byproducts that can serve as cost-effective feed alternatives (Georganas *et al.*, 2023; Shah *et al.*, 2025). Initial proximate analyses of date seed pits reveal a

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composition rich in carbohydrates, dietary fiber (up to 70%) and essential fatty acids, indicating their potential as a bulk energy source in animal nutrition (Kiesler *et al.*, 2024; Al-Mawali *et al.*, 2025).

Beyond their basic nutritional components, date seed pits are notable for their high concentration of bioactive compounds, including polyphenols, flavonoids and tannins (Sejpal *et al.*, 2025). These phytochemicals possess proven antioxidant, anti-inflammatory and antimicrobial properties

(Hossain *et al.*, 2025). While previous studies have explored the incorporation of whole, ground date pits into ruminant diets; primarily focusing on their bulk energy and fiber contribution; the dense, hard seed coat limits digestibility and the systemic bioavailability of these valuable health-promoting compounds (Al-Musawi *et al.*, 2025).

A critical gap exists in understanding how the selective use of an extract, specifically a water-based extract, can modulate animal health and growth performance. By preparing a water extract, the highly polar, health-benefiting phenolic compounds are concentrated, while much of the poorly digestible, bulky fiber is left behind (Khalfi *et al.*, 2024). This approach allows for a direct evaluation of the systemic effects of the date pit's bioactive profile (Selim *et al.*, 2022). Growing goat kids, in particular, require optimal health and immune function to maximize their growth potential, making them an ideal model to test these functional benefits (Zamuner *et al.*, 2023). Therefore, the objectives of this study was to determine the chemical composition of Ekhlas date seeds and to explore whether supplementing suckling Ardi goat kids with a 7.0% date pit water extract would positively impact their health including body weight gain, physiological, hematological and biochemical traits.

MATERIALS AND METHODS

The experimental procedures of the current study were approved by KFU ethical committee. Experiments were conducted in the experimental farm animal research station of KFU University, KSA. The ingredients and chemical composition of the experimental diets were presented in (Table 1 and 2).

Date pits preparation

Ekhlas date fruits were purchased from the seasonal date fruit market, Al-Ahsa, Saudi Arabia during February-March

2025. The seed were separated manually from date flesh and dried in an oven at 50°C and ground into a fine powder using a mill (Pulverisette 19, Germany). The date pit powder weighed and mixed with distilled water (0.7 powder to 10 volume of water) (Al Za'abi *et al.*, 2022). The mixture agitated using a stirrer for 24 hours at 28°C room temperature. The mixture centrifuged 2500-3000 rpm for 15 minutes to separate the solid residue from the liquid extract. The liquid extract poured and filtered using filter paper to remove any remaining fine particles. Each kid was given orally 100 ml of extract per day. The dose and concentration was chosen according to preliminary study and previous study (Ali *et al.*, 1999). The supplementing 7.0% water extract of date pits is a targeted approach to deliver natural, health-promoting antioxidants and polyphenols to growing goat kids.

Chemical composition of date pits

Proximate analysis of date pits and high-performance liquid chromatography was carried out for determination of chemical composition, major and minor elements and phenol compounds (Van Soest *et al.*, 1991; Osman *et al.*, 2019; AOAC 2023; Kalpoutzakis *et al.*, 2023; Osaili *et al.*, 2024).

Ardi goat kids and experimental groups

Twenty growing Ardi goat kids (9.47±0.92) were kept in farm for control and date pits 7.0% water powder extract supplement groups (Fig 1 and Fig 2A-2B). The farm is designed to support the healthy growth of Ardi goat kids, focusing on their well-being, nutrition and environmental needs from birth to weaning and beyond. The facility integrates traditional practices with modern management techniques to ensure productivity and animal welfare. The groups of current study were control group and water date pits group given water extract date pits (7.0%). The goat kids consumed daily ~100.0 ml of water date pits extract through hand-feeding. The temperature (°C) and relative humidity (%) values during the study were 37.50±3.1°C and 39.0±4.0%, respectively.

Monitoring physiological parameters

Body weights gain (g) of control and water extract date pits groups were recorded using digital balance (Sartorius balance, Azulumart-KSA). Physiological parameters were recorded as previously mentioned (Mohammed and Alshaibani 2025; Mohammed *et al.*, 2025b).

Statistical analysis

Body weight gain, physiological parameters and hematological and biochemical profiles of control and water extract date pits groups were statistically analyzed using T-test procedure to compare between the means of two the groups (SAS 2008) according to model:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where,

μ = Mean.

T_i = Effects of 7.0% water extract date pits.

e_{ij} = Standard error.

Table 1: Ingredients of the experimental diets.

Ingredient (% of DM)	Experimental groups	
	Control	Date pits
Alfalfa hay	60.0	60.0
Barley	6.2	11.07
Soybean	1.9	4.0
Wheat bran	28.12	15.18
Soaking date	0.0	7.0
Dicalcium phosphate	1.0	1.0
Limestone	1.99	1.97
Salt	0.69	0.68
Vit. and Min. premix ^a	0.1	0.1

DM: Dry matter.

^a Vit. and Min. premix contains vitamin A 10,000,000 IU, vitamin D₃ 1,000,000 IU, vitamin E 10,000 mg, magnesium 100,000 mg, manganese 50,000 mg, zinc 45,000 mg, iron 80,000 mg, copper 6,000 mg, cobalt 800 mg, iodine 2,500 mg, selenium 100 mg (per kg premix).

Duncan's multiple range test (Duncan 1955) was used to compare between means of control and water extract date pits groups.

RESULTS AND DISCUSSION

Chemical composition of date pits

The chemical composition of Ekhlas date pits is presented in Fig (3A-3B), with all values expressed as a percentage and mg/kg. The chemical analysis shows 3.23% total phenols, 7.29% protein, 9.85% crude fiber, 28.38% total carbohydrates and 0.49% ash. In addition, the mineral contents (mg/kg) of Ekhlas date seeds show 11700 nitrogen, 2039.64 phosphorus, 1015 potassium, 9.026 copper, 238.33 iron, 462.34 magnesium, 10.6 manganese, 11.12 zinc, 0.31 lead and 0.026 cadmium.

Body weight, rectal temperature, SPO² and pulse rate

The values of final body weight (kg) rectal temperature (°C), pulse rate (beats/min.) and SPO² (%) of control and water extract date pit groups are shown in (Table 3). The initial body weights were comparable (Control: 9.62 kg; date pit

extract: 9.33 kg), indicating a successful randomization of animals into the two groups at the start of the trial. The study clearly suggests that the administration of the water extract of date pits had a significant and positive influence on the growth performance and a subtle but significant effect on the thermoregulatory mechanism of the treated goat kids compared to the control group. The values of pulse rate and SPO² were not differed between control and water extract date pits groups.

Hematological and biochemical profiles

The values of blood cells and their traits and biochemical profiles are shown in (Table 4). The date pit water extract significantly improved several blood parameters in the supplemented group. The supplemented date pit water extract group had significantly higher values than control group of RBCs (11.43×10^6 vs. $10.60 \times 10^6/\mu\text{l}$), PCV (37.93 vs. 34.53%) hemoglobin (13.16 vs. 11.95 g/dl), WBCs (15.16×10^3 vs. 13.36×10^3). There were no significant differences in the percentages of neutrophils, lymphocytes or monocytes between the date pit water extract and control groups.

The date pit water extract had a positive impact on several plasma biochemical markers, particularly protein metabolism, liver enzymes and mineral levels. The date pit water extract supplemented group showed significantly higher ($P < 0.05$) values than control group of total protein (6.56 vs. 6.36 g/dl). Concerning to liver enzymes, the levels of aspartate aminotransferase (AST) (51.0 vs. 62.0 U/L), alanine aminotransferase (ALT) (11.33 vs. 17.33 U/L) and gamma-glutamyl transferase (GGT) (27.0 vs. 35.33 U/L) were all significantly lower in the date pit water extract supplemented group compared to control one. This suggests that the extract may have a protective effect on liver function.

Concerning to kidney markers, the levels of urea, creatinine and lactate dehydrogenase were significantly lower in the date pit water extract supplemented group (16.0 mg/dl, 1.28 mg/dl and 63.0 U/L) compared to the control group (17.0 mg/dl, 1.36 mg/dl and 79.66 U/L). This suggests a potential positive effect on kidney health.

Concerning to mineral values, the date pit water extract supplemented group had a highly ($P < 0.0001$) significant increase in both iron and copper levels if compared to control group. This indicates that the date pit extract is a good source of these essential minerals. On other hand, there were no significant differences in glucose, lactate dehydrogenase (LDH) or creatine phosphokinase (CPK) between the date pit water extract and control groups.

The results of the present study showed in Fig (3A-3B) and (Table 3-4) are indicating the effects of 7.0% water extract date pits supplement on body weight gain, physiological parameters, hematological and biochemical profiles of Ardi growing goat kids. Date seed powder has approximately shelf life of 11 months when stored at room temperature (Nandhini and Sathiyar 2022). A critical aspect of the farm is the carefully managed feeding program designed to support the rapid growth of Ardi goat kids.

Table 2: Chemical composition of the experimental diets.

Chemical composition (% of dry matter)	Groups	
	Control	Date pits
Dry matter	89.7	89.8
Crude protein	14.9	14.2
Total digestible nutrients	61.2	61.9
Fat	2.29	2.48
Ash	7.4	6.0
Crude fiber	21.6	23.0
Neutral detergent fiber	42.3	42.2
Acid detergent fiber	26.1	28.9
Calcium	1.87	1.87
Total phosphor	0.7	0.6

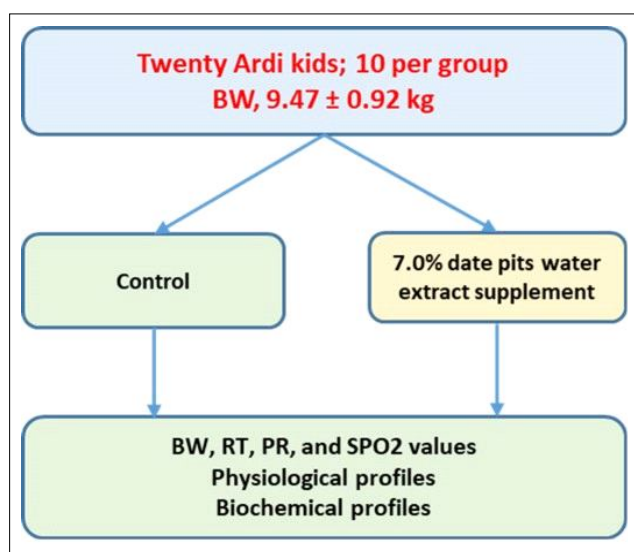


Fig 1: Experimental design and groups of the study.

Chemical composition of date seed pits

The analysis of the chemical composition of Ekhlas date seeds collected from the Al-Ahsa oasis reveals they are a valuable agricultural byproduct with a significant nutritional profile. The results indicate a rich content of both organic compounds and essential minerals, highlighting their potential for various applications beyond simple waste disposal. The analysis of the chemical composition of date pits is indicated in Fig (2A-2B). The proximate and HPLC analyses show 3.23% total phenols, 7.29% protein, 9.85%

crude fiber, 28.38% carbohydrates and 0.49% ash. In addition, the mineral contents (mg/kg) of Ekhlas date seeds show 11700 nitrogen, 2039.64 phosphorus, 1015 potassium, 9.026 copper, 238.33 iron, 462.34 magnesium, 10.6 manganese, 11.12 zinc, 0.31 lead and 0.026 cadmium. The composition of date pits is influenced by the varieties, growing conditions, location and processing extraction technique (Hossain *et al.*, 2014; Bouhlali *et al.*, 2017; Mrabet *et al.*, 2020, 2022; Amin *et al.*, 2023). Date seeds are contained approximately ranges from 5-10% moisture, 4-7% protein, 6-12% oil, 75-81%



Fig 2: Date pits powder (A) and 7.0% date pits water extract (B).

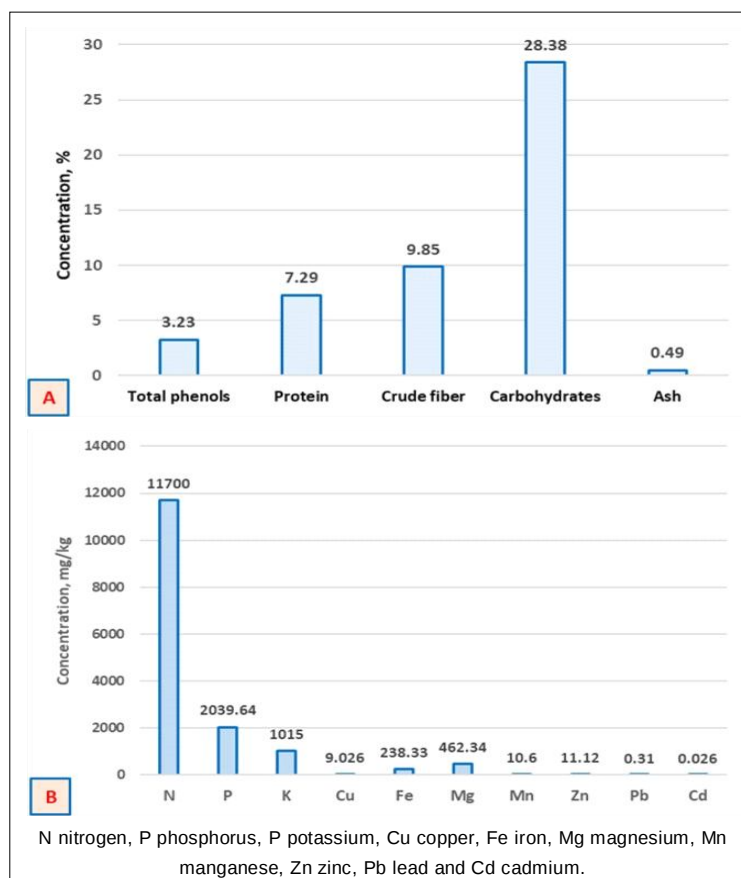


Fig 3: Organic (A, %) and inorganic (B, mg/kg) contents of Ekhlas date seeds of Al Ahsaa oasis.

carbohydrates and 1% ash. Macro elements, including calcium (28-62 mg/100 g), phosphorus (68-83 mg/100 g), potassium (229-400 mg/100 g), magnesium (51-282 mg/100 g) and iron (2-4 mg/100 g), are present in considerable amounts as well (Attia *et al.*, 2021). The total phenolic compounds ranged from 1.05 to 1.24 mg/g in Reziz and Naghal varieties (Osaili *et al.*, 2024) compared to 3.23 mg/g of total phenolic compounds in this study. Date pits should be seen as valuable resources based on these findings.

Body weight and physiological parameters

The most notable result is the significantly higher final body weight in the group treated with the date pit water extract compared to the Control group (16.28 vs. 14.21 kg) (Table 3). This suggests that the date pit water extract contains bioactive compounds that promote growth or improve feed efficiency, leading to enhanced weight gain. Date pits are known to be rich in various components, including

polyphenols, flavonoids and fiber and their consumption in feed or as an extract has been studied for its potential health and growth-promoting effects, possibly due to improved nutrient utilization or antioxidant properties. The greater weight gain demonstrates a clear biological or nutritional benefit from the extract (Rahman *et al.*, 2007; Rehman *et al.*, 2017; Swaidan *et al.*, 2023; Alkatheri *et al.*, 2024; Mohammed *et al.*, 2025a).

The group receiving the date pit extract exhibited a significantly higher rectal temperature compared to the Control (38.80 vs. 38.60°C). A slight increase in body temperature can sometimes be associated with higher metabolic activity or a mild pyrogenic effect, though the value 38.80°C remains within a healthy physiological range for many livestock species. Given the greater final body weight, the increased temperature is more likely linked to a higher growth rate and metabolic turnover rather than an adverse health effect (Hollstein and Piaggi, 2020).

Table 3: Rectal temperature (°C), pulse rate and peripheral oxygen saturation (%) of growing Ardi goat kids supplemented water extract date pits.

Parameters	Control	Water extract date pits	SEM	P value
Initial body weight, kg	9.62	9.33	0.94	0.92
Final body weight, kg	14.21 ^b	16.28 ^a	0.88	0.01
Rectal temperature, °C	38.60 ^b	38.80 ^a	0.06	0.03
Pulse rate/min.	126.67	122.50	3.81	0.91
Peripheral oxygen saturation, %	92.00	93.67	1.85	0.87

^{a,b} Values between water extract date pits and control groups in the same row with different superscripts significantly differ at $P < 0.05$. SEM: Standard error of means.

Table 4: Changes in blood cells and their traits and biochemical of Ardi goat kids receiving water extract date pits.

Parameters	Control	Water extract date pits	SEM	P value
Blood profiles				
RBCs, $10^6/\mu\text{l}$	10.60 ^b	11.43 ^a	0.45	0.001
Hemoglobin, g/dl	11.95 ^b	13.16 ^a	0.86	0.04
Packed cell volume, %	34.53	37.93	0.48	0.05
WBCs, $10^3/\mu\text{l}$	13.36 ^b	15.16 ^a	0.59	<0.0001
Neutrophils, %	46.4	47.7	1.00	0.80
Lymphocytes, %	47.1	45.56	1.12	0.90
Monocytes, %	5.55	5.66	0.12	0.30
Plasma profiles				
Total protein, g/dl	6.36 ^b	6.56 ^a	0.14	0.05
Glucose, mg/dl	119.66	117.0	3.73	0.80
Urea, mg/dl	17.0 ^a	16.0 ^b	0.76	0.05
Creatinine, mg/dl	1.36 ^a	1.28 ^b	0.084	0.05
Aspartate aminotransferase, U/L	62.0 ^a	51.0 ^b	5.15	0.01
Alanine aminotransferase, U/L	17.33 ^a	11.33 ^b	1.45	<0.0001
γ -Glutamyl transferase, U/L	35.33 ^a	27.0 ^b	3.05	<0.0001
Lactate dehydrogenase, U/L	79.66 ^a	63.0 ^b	4.96	<0.0001
Creatine phosphokinase, U/L	527.33	512.6	13.54	0.80
Iron, mg/dl	41.66 ^b	53.6 ^a	3.92	<0.0001
Copper, mg/dl	52.66 ^b	64.33 ^a	4.12	<0.0001

^{a,b} Values between water extract date pits and control groups in the same row with different superscripts significantly differ at $P < 0.05$. SEM: Standard error of means.

The other parameters including pulse rate and peripheral oxygen saturation showed no significant difference between the two groups. This is a crucial finding, as it indicates that the growth-promoting effect of the date pit extract does not appear to impose undue stress on the cardiovascular or respiratory systems. The animals' heart function and blood oxygen levels remain stable, suggesting the extract is well-tolerated and promotes healthy growth.

Hematological and biochemical profiles

The values of blood cells and their traits and biochemical profiles are shown in (Table 4). The data indicates that supplementing growing Ardi goat kids with a date pit water extract significantly and positively influenced their blood and plasma profiles, suggesting an overall improvement in their health status. The hematological and biochemical parameters of experimental groups fell within the normal range of growing goat kids (AL-Suwaiegh 2016; Zaher *et al.*, 2022; Fanta *et al.*, 2024).

The date pit water extract had a strong positive effect on key blood components. The supplemented group showed a significant increase in the count of both red blood cells (RBCs) and white blood cells (WBCs), along with higher levels of hemoglobin and packed cell volume (PCV). These results suggest improved oxygen-carrying capacity and a more robust immune system. Interestingly, while the total WBC count increased, the percentages of specific white blood cells (neutrophils, lymphocytes and monocytes) remained unchanged, indicating a uniform boost to the immune response rather than a targeted one. The supplement also had a beneficial impact on the kids' plasma chemistry. The supplemented group had significantly lower levels of liver enzymes-including aspartate aminotransferase (AST), alanine aminotransferase (ALT) and gamma-glutamyl transferase (GGT), which suggests a protective effect on liver function. Similarly, the lower levels of urea and creatinine point to improved kidney function. The study also showed a significant increase in the levels of iron and copper in the blood, indicating that the date pit extract is either a direct source of these essential minerals or enhances their absorption. Overall, the findings strongly support the conclusion that a date pit water extract is a safe and effective nutritional supplement for young animals, promoting better blood health and organ function.

The health benefits of date pit water extract could be attributed to its nutritional content. It's high in antioxidants and a good source of dietary fiber, which can help with digestion. The extract may also have properties that could help manage diabetes and reduce inflammation. Furthermore, it is rich in essential minerals and may support a healthy cardiovascular system and promote good gut health (Ghafoor *et al.*, 2022; Manai *et al.*, 2024; Mohammed *et al.*, 2025a). The date seed oils are an important regarding their fatty acid composition and remarkable high amount of tocopherol contents (Al-Juhaimi *et al.*, 2018). Date pits are particularly rich in polyphenols,

including phenolic acids and flavonoids (Osaili *et al.*, 2024). These compounds are well-known for being powerful antioxidants that protect the body from damage caused by oxidative stress, leading to various health benefits. In summary, date seeds are far from mere waste. The distinct chemical properties of dates including abundance of fibers, oils and diverse phenolic compounds make them a strong candidate for various beneficial applications. This is particularly relevant for regions like Al-Ahsa, where extensive date production can support sustainability and economic growth.

CONCLUSION

The results strongly support the hypothesis that the water extract of Ekhlas date pits is an effective supplement for enhancing the growth of the Ardi goat kids, evidenced by the significant increase in final body weight. This benefit is achieved without causing any significant disturbance to key vital signs including blood health, liver and kidney functions.

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Disclaimers

The conclusions and views expressed in this paper are solely those of the authors and do not represent the views of their affiliated institutions.

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Informed consent

Animal cares and experimental procedures were approved by the ethical committee of scientific research at King Faisal University (KFU253693).

Conflict of interest

The authors have declared no conflict of interest.

REFERENCES

- Al Za'abi, M., Ali, B.H., Ali, H., Manoj, P., Ashique, M., Nemmar, A. and Cahlíková, L. (2022). The effect of an extract and fractions of date pits on some plasma constituents, reproductive hormones and testicular histology in male mice. *Scientific World Journal*. pp. 4102960.
- Al-Habsi, N. (2025). Date palm (*Phoenix dactylifera* L.) fruit: Strategic crop for food security, nutritional benefits, postharvest quality and valorization into emerging functional products. *Sustainability*. **17**: 7491.
- Ali, B.H., Bashir, A.K. and Alhadrami, G.A. (1999). Reproductive hormonal status of rats treated with date pits. *Food Chemistry*. **66**(4): 437-441.

- Al-Juhaimi, F., Özcan, M.M., Adiamo, O.Q., ALSawmahi, O.N., Ghafoor, K. and Babiker, E.E. (2018). Effect of date varieties on physico-chemical properties, fatty acid composition, tocopherol contents and phenolic compounds of some date seed and oils. *Journal Food Processing Preservation*. **42**: e13584.
- Al-Karmadi, A. and Okoh, A.I. (2024). An overview of date (*Phoenix dactylifera*) fruits as an important global food resource. *Foods*. **13**(7): 1024.
- Alkatheri, A.H., Alkatheeri, M.S., Cheng, W.H., Thomas, W., Lai, K.S. and Lim, S.H. E. (2024). Innovations in extractable compounds from date seeds: Farms to future. *AIMS Agriculture and Food*. **9**(1): 256-281.
- Al-Mahmoud, M.E., Al-Dous, E.K., Al-Azwani, E.K. and Malek, J.A. (2012). DNA-based assays to distinguish date palm (*Arecaceae*) gender. *American Journal Botany*. **99**(1): e7-10.
- Al-Mawali, M., Al-Khalili, M., Al-Khusaibi, M., Myint, M.T.Z., Kyaw, H.H., Rahman, M.S., Muhammad, A.I. and Al-Habsi, N. (2025). Physicochemical and structural characteristics of date seed and starch composite powder as prepared by heating at different temperatures. *Polymers*. **17**(14): 1993.
- Al-Musawi, J.E., Dakheel, M.M. and Wadi, B.J. (2025). Effects of ground dates on rumen fermentation and milk composition parameters in local ewes. *Open Veterinary Journal*. **15**(6): 2798-2805.
- AL-Suwaiegh, S.B. (2016). Effect of feeding date pits on milk production, composition and blood parameters of lactating ardi goats. *Asian-Australasian Journal of Animal Sciences*. **29**(4): 509-515.
- Amin, E., Mohamed, E.I.A., Alenezi, A.S., Aldwesh, M.A., Sebak, M., Naguib, I.A., Bukhari, S.I., Bukhari, K., Zaki, M.A. and Affi, N. (2023). Pattern recognition of phytoconstituents and bioactivities of date pit extracts from different cultivars grown in the qassim area. *Separations*. **10**: 102.
- AOAC. (2023). Association of Official Analytical Chemists. Official Methods of Analysis, 22nd ed. AOAC, Arlington, VA.
- Attia, A.I., Reda, F.M., Patra, A.K., Elnesr, S.S., Attia, Y.A. and Alagawany, M. (2021). Date (*Phoenix dactylifera* L.) by-products: Chemical composition, nutritive value and applications in poultry nutrition, an updating review. *Animals*. **11**(4): 1133.
- Bouhlali, E.T., Alem, C., Ennassir, J., Benlyas, M., Mbark, A.N. and Zegzouti, Y.F. (2017). Phytochemical compositions and antioxidant capacity of three date (*Phoenix dactylifera* L.) seeds varieties grown in the South East Morocco. *Journal of the Saudi Society of Agricultural Sciences*. **16**(4): 350-357.
- Capanoglu, E., Nemli, E. and Tomas-Barberan, F. (2022). Novel approaches in the valorization of agricultural wastes and their applications. *Journal of Agricultural and Food Chemistry*. **70**(23): 6787-6804.
- Costa, J.M.C., Oliveira, D.M. and Costa, L.E.C. (2018). Macauba Palm-*Acrocomia Aculeata*. In: Exotic Fruits. [Rodrigues, S., de Oliveira Silva, E., de Brito, E.S., (eds)]. Academic Press; Cambridge, MA, USA. pp. 297-304.
- Duncan, D.B. (1955). Multiple range and multiple Ftest. *Biometrics*. **11**: 1.
- Fanta, Y., Kechero, Y. and Yemane, N. (2024). Hematological parameters of sheep and goats fed diets containing various amounts of water hyacinth (*Eichhornia crassipes*). *Frontiers Veterinary Science*. **11**: 1286563.
- Farag, K.M. (2016). Date Palm: A Wealth of Healthy Food. In: Encyclopedia of Food and Health. [Caballero, B., Finglas, P.M., Toldrá, F., (eds)]. Academic Press; Oxford, UK. pp. 356-360.
- Georganas, A., Giamouri, E., Pappas, A.C., Zoidis, E., Goliomytis, M. and Simitzis, P. (2023). Utilization of agro-industrial by-products for sustainable poultry production. *Sustainability*. **15**(4): 3679.
- Ghafoor, K., Sarker, M.Z.I., Al-Juhaimi, F.Y., Babiker, E.E., Alkaltham, M.S. and Almubarak, A.K. (2022). Extraction and evaluation of bioactive compounds from date (*Phoenix dactylifera*) seed using supercritical and subcritical CO₂ techniques. *Foods*. **11**(12): 1806.
- Hollstein, T. and Piaggi, P. (2020). Metabolic factors determining the susceptibility to weight gain: Current evidence. *Current Obesity Reports*. **9**(2): 121-135.
- Hossain, M.S., Wazed, M.A., Asha, S., Amin, M.R. and Shimul, I.M. (2025). Dietary phytochemicals in health and disease: Mechanisms, clinical evidence and applications-a comprehensive review. *Food Science and Nutrition*. **13**(3): e70101.
- Hossain, M.Z., Waly, M.I., Singh, V., Sequeira, V. and Rahman, M.S. (2014). Chemical compositions of date-pits and its potential for developing value-added product-A review. *Pol. J. Food Nutr. Sci*. **64**(4): 215-226.
- Kalpoutzakis, E., Chatzimitakos, T., Athanasiadis, V., Mitakou, S., Aliannis, N., Bozinou, E., Gortzi, O., Skaltsounis, L.A. and Lalas, S.I. (2023). Determination of the total phenolics content and antioxidant activity of extracts from parts of plants from the greek island of crete. *Plants (Basel)*. **12**(5): 1092.
- Khalfi, A., Garrigós, M.C., Ramos, M. and Jiménez, A. (2024). Optimization of the microwave-assisted extraction conditions for phenolic compounds from date seeds. *Foods*. **13**(23): 3771.
- Kiesler, R., Franke, H. and Lachenmeier, D.W. (2024). A comprehensive review of the nutritional composition and toxicological profile of date seed coffee (*Phoenix dactylifera*). *Applied Sciences*. **14**(6): 2346.
- Liu, Z., de Souza, T.S.P., Holland, B., Dunshea, F., Barrow, C. and Suleria, H.A.R. (2023). Valorization of food waste to produce value-added products based on its bioactive compounds. *Processes*. **11**(3): 840.
- Manai, S., Boulila, A., Silva, A.S., Barbosa-Pereira, L., Sendón, R. and Khwaldia, K. (2024). Recovering functional and bioactive compounds from date palm by-products and their application as multi-functional ingredients in food. *Sustainable Chemistry and Pharmacy*. **38**: 101475.
- Mohammed, A.A. and Alshaibani, N. (2025). Physiological and biochemical characteristics of majaheem and waddah camel breeds under extensive management system. *Indian Journal of Animal Research*. **59**(12): 2000-2005. doi: 10.18 805/IJAR.BF-1975.

- Mohammed, A.A., Al-Suwaiegh, S., AlGherair, I., Al Sornokh, H. and Mohammed, M.A. (2025a). Potential impact of dietary and water extract date pits consumption on health profiles in mice. *Indian Journal of Animal Research*. doi: 10.18805/IJAR.BF-2028.
- Mohammed, A.A., Sayed, El. M.S., AlGherair, I. and Al-Suwaiegh, S. (2025b). The potential influence of *coleus forskolii*, green coffee and green tea on body weight, reproductive performance, hematological profiles in mice. *Indian Journal of Animal Research*. **59(8)**: 1295-1302. doi: 10.18805/IJAR.BF-1916.
- Mrabet, A., Jiménez-Araujo, A., Fernández-Prior, Á., Bermúdez-Oria, A., Fernández-Bolaños, J., Sindic, M. and Rodríguez-Gutiérrez, G. (2022). Date seed: Rich source of antioxidant phenolics obtained by hydrothermal treatments. *Antioxidants (Basel)*. **11(10)**: 1914.
- Mrabet, A., Jiménez-Araujo, A., Guillén-Bejarano, R., Rodríguez-Arcos, R. and Sindic, M. (2020). Date seeds: A promising source of oil with functional properties. *Foods*. **9**: 787.
- Nandhini, K.R. and Sathiya, V. (2022). Formulation, standardisation, proximate composition and shelf life analysis of palm date seeds (*Phoenix dactylifera*) coffee powder. *International Journal Home Science*. **8**: 27-31.
- Osaili, T.M., Swaidan, A., Al-Nabulsi, A., Olaimat, A., Neugart, S., Engelhardt, L., Esatbeyoglu, T., Ayyash, M., Ismail, L.C., Al-Dabbas, M.M., Obaid, R.S. and El Darra, N. (2024). Assessment of the phenolic profile and biological activities of aqueous date seed extracts: A comparative analysis. *Applied Food Research*. **4(2)**: 100493.
- Osman, N.S., Khamil, I.A.M. and Sapawe, N. (2019). Proximate analysis of animal feed pellet formulated from sunflower shell waste. *Materials Today: Proceedings*. **19(4)**: 1796-1802.
- Paolino, R., Di Trana, A., Coppola, A., Sabia, E., Riviezz, A.M., Vignozzi, L., Claps, S., Caparra, P., Pacelli, C. and Braghieri, A. (2025). May the extensive farming system of small ruminants be smart? *Agriculture*. **15**: 929.
- Rahman, M.S., Kasapis, S., Al-Kharusi, N.S.Z., Al-Marhubi, I.M. and Khan, A.J. (2007). Composition characterization and thermal transition of date pits powders. *Journal Food Engineering*. **80**: 1-10.
- Rehman, N.U., Hussain, H., Al-Broumi, M.A., Khiat, M., Csuk, R., Al-Rawahi, A., Khan, A.L., Mabood, F., Green, I.R. and Al-Harrasi, A. (2017). Composition and biological activities of different date seed varieties of oman: Cultivation zone influence. *International Journal of Phytomedicine*. **9(1)**: 29.
- SAS (2008). SAS User's Guide: Basics. Statistical Analysis System Institute, Inc., Cary, NC, USA.
- Sejpal, M.A., Shi, L., Xie, R., Ghafoor, K., Ahmadi, F. and Suleria, H.A.R. (2025). Date palm fruit (*Phoenix dactylifera* L.): Structure, ripening, nutrition and applications. *Discover Chemistry*. **2**: 169.
- Selim, S., Abdel-Mawgoud, M., Al-sharary, T., Almuhayawi, M.S., Alruhaili, M.H., Al Jaouni, S.K., Warrad, M., Mohamed, H.S., Akhtar, N. and AbdElgawad, H. (2022). Pits of date palm: Bioactive composition, antibacterial activity and antimutagenicity potentials. *Agronomy*. **12(1)**: 54.
- Shah, A.M., Zhang, H., Shahid, M., Ghazal, H., Shah, A.R., Niaz, M., Naz, T., Ghimire, K., Goswami, N., Shi, W., Xia, D. and Zhao, H. (2025). The vital roles of agricultural crop residues and agro-industrial by-products to support sustainable livestock productivity in subtropical regions. *Animals (Basel)*. **15(8)**: 1184.
- Shi, L., de Souza, T.S.P., Ahmadi, F., Imran, A., Dunshea, F.R., Barrow, C. and Suleria, H.A.R. (2023). Valorization of date fruit (*Phoenix dactylifera* L.) processing waste and by-products: A review. *Applied Sciences*. **13(22)**: 12315.
- Swaidan, A., Azakir, B., Neugart, S., Kattour, N., Sokhn, T.M., Osaili, E.S. and Darra, N.El. (2023). Evaluation of the phenolic composition and biological activities of six aqueous date (*Phoenix dactylifera* L.) seed extracts originating from different countries: A comparative analysis. *Foods*. **13(1)**: 126.
- Van Soest, P.J., Robertson, J.B. and Lewis, B.A. (1991). Methods for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. *Journal Dairy Science*. **74(10)**: 3583-3597.
- Zaher, H.A., Mesalam, A., Al Bloushi, A.I., Tolba, A., Swelum, A.A. and Abu-Alrub, I. (2022). Hematological and biochemical indices, growth performance and puberty of goats fed with Mombasa and blue panic as salt-tolerant alternatives to alfalfa under arid conditions. *Frontiers Veterinary Science*. **9**: 961583.
- Zamuner, F., Leury, B.J. and DiGiacomo, K. (2023). Review: Feeding strategies for rearing replacement dairy goats-from birth to kidding. *Animal*. **17(6)**: 100853.