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Physico-Chemical and Sensorial Properties of Ketchup Enriched with Khalas Date Pits Powder

Nashi Khalid Alqahtani

Department of Food and Nutrition Sciences, College of Agricultural and Food Sciences, King Faisal University
Al Ahsa, Saudi Arabia

الخواص الطبيعية والكيماوية والحسية للكاتشب المعزز بمطحون نوى تمر الخلاص

ناشي خالد القحطاني

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ABSTRACT

The importance of date pits as agricultural waste and rich in dietary fibre, despite their limited application in food processing. On the other hand, the enrichment of ketchup with novel fibre sources is considered a research and development objective. Therefore, this study was conducted to determine the effects of tomato ketchup enriched with (Khalas) date palm pits (Phoenix dactylifera) powder (DPP) as a source of dietary fibre on the colour, chemical attribute, rheological properties and sensory evaluation of tomato ketchup. Different concentrations of DPP (0.00; 0.25; 0.50; 1.00; and 1.50%) were used. It was observed that the enrichment of ketchup with DPP slightly increases L-value and slightly decreases a/b value. There was no difference in the total soluble solids content (Brix) between ketchup treatments at the storage period ($P<0.05$), which ranged between 28.14–29.8%. The acidity and pH of DPP treatments showed similarities during the storage period. Tomato–date pits ketchup treatments (0.25% and 1.5%) increased viscosity at the beginning of storage and decreased later during storage. The highest hardness, adhesiveness, and bostwick values were found in 0.5% DPP treatment compared with control during the storage period. The highest sensory evaluation scores were observed in treatments of 0.25% and 0.5%. The obtained results are promising regarding novel fibre sources in the applied processing of tomato ketchup.

الملخص

أهمية نوى التمر كمخلف زراعي تكمن في ثرائه بالألياف الغذائية رغم محدودية تطبيقاته في التصنيع الغذائي. وعلى نحو آخر يعد التعزيز بمصادر مبتكرة من الألياف الغذائية غاية بحثية للتطوير والبحث في إنتاج الكاتشب، الأمر الذي استهدفته هذه الدراسة لتوصيف تأثيرات تعزيز كاتشب الطماطم بمطحون نوى تمر الخلاص كمصدر مبتكر للألياف الغذائية (87.3%) على السمات اللونية، الكيميائية، الانسيابية والحسية؛ حيث تمت إضافة تركيزات مختلفة من مطحون نوى التمر تراوحت نسبتها المئوية بين 0.0، 0.25، 0.5، 1.0، 1.5. وقد لوحظ أن هذا التعزيز أثر بالزيادة الطفيفة على قيم L، والنقصان الطفيف في نسبة a/b المعبرة عن محاور الألوان المتضادة. ولم تكن هناك اختلافات معنوية في محتويات معاملات الكاتشب المعزز من الجوامد الكلية خلال فترة التخزين التي تراوحت بين (28.14 -29.8 %). كما أظهرت نتائج الحموضة والأس الهيدروجيني لعينات المعاملات تماثلاً خلال فترة التخزين. معاملات 0.25، 1.5 % زادت فيها اللزوجة في بداية التخزين بينما تناقصت خلال فترة التخزين. ووجد أن أعلى قيم للصلابة والالتصاق ومعامل القوام bostwick كانت لعينات المعاملة 0.5% مقارنة بالعينة الضابطة خلال فترة التخزين، كما سجلت عينات المعاملات 0.25،0.5% أعلى قيم للقبول الحسي. إن النتائج المتحصل عليها واعدة تجاه التطبيق التصنيعي لتعزيز كاتشب الطماطم بمطحون نوى التمر كمصدر مبتكر للألياف الغذائية.

1. Introduction

Saudi Arabia is reported to be the global leader in the production of dates, with an annual production of 9 million tons (FAO 2016). Dates harvested from the farms are processed, producing the waste product known as pits or kernels, which can be processed further to get a gelling agent. Pits constitute approximately 12–15% of the date fruit weight, depending on the variety (Soliman *et al.,* 2010; Mirghani, 2012). Date pits are an odorless and excellent source of fibre compared to the fleshy parts of the date (Almana and Mahmoud, 1994; Hussein *et al.,* 1998). As such, dates can be constituted to provide gelling agents for the food industry. Date pits should therefore be explored for economic value in the food industry and other sectors, such as nutraceutics and pharmaceutics (Viscione, 2013; Scott–Thomas, 2013).

Habib and Ibrahim (2009), Suresh *et al.* (2013) and Ashour, (2015) reported that date pits contain dry matter 5–10% moisture, 5–7% protein, 7–10% fat, 10–20% crude fibres, 55–65% carbohydrates and 1–2% ash. Date pit carbohydrates contain neutral detergent fibres (75%), acid detergent fibres (57.5%), hemicelluloses (17.5%), lignin (11%), cellulose (42.5%) and ash (4%). Date pits have fibres and other bioactive components, such as polyphenols, which make them potential value-adding components in the food production sector (Platat *et al.*, 2014). The functionality and structural properties of date pits are promising and have the potential to many values such as oil contents (Tafti *et al.*, 2017), fibres and bioactive components such as phenolics (Ghnimi *et al.,* 2017). On the other hand, date pit potentiality was reported for thermal characteristics (Suresh *et al.*, 2013), antioxidant activities (Priyatharini and Fereidoon, 2015; El-Rahman and Al-Mulhem, 2017), antiviral activities (Jassim and Naji, 2010), and nutritional value (Platat *et al.,* 2014; Al meqbaali *et al.,* 2017).

Limited studies indicate that date pits can be used as an alternative source of dietary fibre in bread enrichment (Almana and Mahmoud, 1994), a coffee-substitute in hot beverages (Rahman *et al.* 2007) and jam production (Mirghani *et al.*, 2012; Sedra, 2016). The presence of the significant amounts of fibres, proteins, fats and carbohydrates in date pit powder (DPP) functionally make it potential nutritionally for supporting food products. In addition to being odorless, stable, and an anti-oxidative, its higher fibre content makes DPP a good nutraceutical and pharmaceutical ingredient (Metoui *et al.* 2019; Al-Thubiani and Khan 2017). Ketchup is a low-calorie, processed tomato product. It is widespread, familiar and easy to use (Sarkar and Kaul, 2014). It is made from tomato concentrate, sugar, vinegar, salt and different spices. Typically, ketchup is not refrigerated in stores. The consistency of tomato ketchup is an important attribute and can be affected by different storage temperatures. Incorrect storage may lead to separation, the loss of consistency and negative consumer acceptability. This can be avoided by using thickening agents or hydrocolloids such as guar gum, xanthan, tragacanth, pectin and sodium alginate (Koocheki *et al.*, 2009), or modified starches (Juszczak *et al.*, 2013) and a combination of angum gum and tragacanth gum (Komeilyfard *et al.*, 2017)

According to Al-Mari (2016), date pits can be used to produce low-calorie tomato ketchup. Tomato ketchup is made up of vinegar, salt and sugar, and kept outside the refrigerator to ensure that the sugar

Corresponding Author: Nashi K. Alqahtani nalqahtani@kfu.edu.sa المؤلف المراسل: ناشي خالد القحطاني

and other ingredients remain suspended in the tomato juice. The common suspending agents used in formulating tomato ketchup include hydrocolloids such as guar gum, xanthan, tragacanth, pectin, and sodium alginate. However, these agents have been associated with challenges such as the formation of stable floccules, rapid sedimentation, phase inversion and cracking; therefore, they are ineffective ingredients in ketchup formulation. Xanthan, tragacanth, pectin, and sodium alginate are unstable in extreme temperatures, thus limiting the product's shelf life.

The stability of tomato ketchup can be enhanced by adding powdered date pits that will also enhance the product's viscosity and ease dispensing from the container. According to Dhahri *et al.* (2018), the ketchup's viscosity is an important attribute from both the formulation and consumption viewpoint. The viscosity of ketchup determines the rheological properties, which are also dependent on the temperature of the storage condition. As such, the use of stable gelling agents such as date pits will ensure the stability of the tomato ketchup in different storage conditions and the ability to avoid challenges such as phase separation, loss of consistency and consumer unacceptability (Koocheki *et al.*, 2009; Prakash *et al.*, 2016). The purpose of this research is to determine the rheological, chemical and organoleptic properties of ketchup enriched with khalas date pits as a source of dietary fibre. The study findings should help enhance ketchup consistency and increase the application of date pits in the food production industry.

2. Material and Methods

2.1. Materials:

2.1.1. Date pits powder

Local khalas date pits from the Al-Ahsa region of Saudi Arabia were prepared according to Suresh *et al.* (2013). Khalas date pits were washed and oven-dried at 50° C for 48 hours, crushed and milled using (Guangzhou Mingyue – China) a grinding mill (Platat *et al.*, 2014). According to Habib and Ibrahim (2009), the chemical composition of khalas date pits (g/100 g) is 7.5, 10.5, 5.7, 1.05 and 78.3% for moisture, fat, protein, ash and fibre, respectively.

2.1.2. Ingredients and experimental design

Tomato concentrate and other ingredients (Table 1) were used to produce tomato ketchup with varying percentages of date pit powder. All ingredients were obtained locally for tomato ketchup preparations as follows:

Table 1: Formulation of tomato ketchup treatments with different percentages of Khalas date pit powder

	Percentage of Khalas date pit powder (treatments)									
	Control (0%)		1 (0.25%)		2 (0.5%)		3 (1.0%)		4 (1.5%)	
Ingredients	gm*	%	gm*	%	gm*	%	gm*	%	gm*	%
Tomato conc. 36%	157.7	12.62	155.1	12.41	152.5	12.2	147.2	11.78	142.1	11.36
Date pits Powder	0	0	3.124	0.25	6.268	0.5	12.53	1	18.71	1.5
Sugar	272	21.76	272.8	21.83	273.7	21.9	275.5	22.04	277.2	22.17
Salt	24.48	1.96	24.55	1.96	24.63	1.97	24.79	1.98	24.95	2
Modified Starch	43.51	3.48	43.65	3.49	43.79	3.5	44.07	3.53	44.35	3.55
Vinegar 11%	97.9	7.83	98.22	7.86	98.53	7.88	99.16	7.93	99.79	7.98
Cinnamon powder	0.154	0.01	0.154	0.01	0.155	0.01	0.156	0.01	0.157	0.01
Onion powder	0.249	0.02	0.25	0.02	0.25	0.02	0.252	0.02	0.254	0.02
Garlic powder	0.102	0.01	0.102	0.01	0.103	0.01	0.103	0.01	0.104	0.01
Hot sauce powder	0.102	0.01	0.102	0.01	0.103	0.01	0.103	0.01	0.104	0.01
Ginger powder	0.34	0.03	0.341	0.03	0.342	0.03	0.344	0.03	0.346	0.03
Cloves powder	0.023	0.001	0.023	0.001	0.023	0.001	0.023	0.001	0.024	0.001
Hot sauce flavour	0.272	0.02	0.273	0.02	0.274	0.02	0.275	0.02	0.277	0.02
Water	653.2	52.25	651.3	52.1	649.3	51.95	645.5	51.64	641.7	51.34
Total	1250	100	1250	100	1250	100	1250	100	1250	100

*** Trail batch preparations (1.250 kg of final product).**

2.1.3. Preparation of tomato ketchup

The ketchup was prepared according to Komeilyfard *et al.* (2017). Concentrated tomato paste was diluted to 12% Total Soluble Solids (TSS) according to the formulation. Then the mixture was placed into an open pan, and spices (i.e. onion, garlic, cloves, cinnamon, ginger and hot sauce powder) were added. The mixture was heated on a hot plate, set at a moderate temperature, and stirred continuously until the mixture reached the desired temperature of 80 °C. During the final stages of cooking, date pits powder was pre-blended with the sugar and salt, then added to the ketchup and stirred for two minutes at 4000·g with an electric blender (Thermomix vorwerk TM31, Germany). The mixture was concentrated to the TSS content of 24%. Vinegar and paprika extracts were added to the mixture, and the ketchup was heated until a TSS of 26.5% was obtained. The final TSS of all ketchup samples was 28%. The final levels of each DPP added by weight in ketchup samples were 0.0 (control), 0.25%, 0.5, 1.0, or 1.5%. While still hot, ketchup samples were poured into glass jars, sealed with rubber seal screw caps, then stored at ambient temperature (20–22 °C) for 24 hours before the analyses.

2.2. Methods:

2.2.1. Colour and chemical analysis

The samples' colour was measured by units standard $L^*a^*b^*$ (L^* for the lightness, a^* and b^* for the green–red and blue–yellow colour components) using Hunter Lab colour measurement (CIE, 2004). Colour measurement in $L^*a^*b^*$ units were measured in glass sample cups of Hunter Lab (colour flex®) instrument (Reston, VA, USA) according to Hunter and Richard (1987). The pH was measured using Denver Instrument, USA. Acidity as acetic acid and Sodium chloride was determined according to AOAC (2000). Total Soluble Solids (TSS, °Brix) was determined using Abbe Refractometer Model 10494 according to AOAC Official Method (2006).

2.2.2. Physical analysis

The final product was measured by Bostwick consistometer according to Porretta (1991), using the recommendations of ASTM Standard (ASTM International, 2002). Viscosity (centipois) was detected by viscosity Brokfield (DV3+ pro. USA). Hardness and Adhesiveness of the tomato ketchup samples were measured by Brookfield Rheometer (type 10K USA) according to Sit *et al.* (2014)

2.2.3. Statistical analysis

All treatments were analysed using the ANOVA test expressed at the 5% level ($p<0.05$) statistical significance level using SPSS software.

2.2.4. Sensory evaluation

Six ketchup industry quality control experts carried out the sensory evaluation. Twenty degrees were assigned for each attribute, except overall acceptability, which has 100 degrees. The sensory evaluation was conducted according to Jimenez *et al.* (1989).

3. Results and Discussion

3.1. Colour Measurements:

The results of the colour indices *(L*, a*, b*, a/b)* in (Table 2) showed a high value of L more than the control, which was attributed to the lightness of ketchup. The a/b values of control were significantly higher than DPP treatments. However, insignificant differences were observed in terms of values among other samples. The addition of date pits to ketchup slightly increased lightness (L value) and slightly decreased (a/b) value.

Tabibloghmany and Ehsandoost (2013) reported that ketchup affected by different concentrations of linseed gum was noticed. The b* value of all treatments differed significantly. The b*values ranged from 11.03–11.49. The lightest and darkest treatments were related to samples with 1% and 0.5% Linseed, respectively. On the other hand, Sit *et al.* (2014) reported that ketchup colour was not influenced by a 2% starch addition during 30 days of storage.

Ketchup containing 0.5% angum gum was significantly lower than others. Also, ketchup containing 1% tragacanth gum showed no significant effect on the colour indices (L*, a*, b*, hue angle, chroma and total colour differences) (Komeilyfard *et al.*, 2017). Torbica *et al.* (2016) recommended not adding colour enhancers to the formulation of ketchup supported with dietary fibre.

Table 2: Colour measurements of tomato ketchup treatments with different percentages of Khalas date pit powder.

Storage Time (Months)	Concentration (%)	L*	a*	b*	a/b
0	0	29.55x ± 0.01	16.47defgh ± 0.06	11.95q ± 0.01	1.38c ± 0.01
	0.25	29.13z ± 0.01	16.24ghi ± 0.46	12.83n ± 0.06	1.27hi ± 0.03
	0.5	30.17s ± 0.06	16.43gh ± 0.27	13.91ef ± 0.01	1.18no ± 0.02
	1	29.62w ± 0.02	16.26ghi ± 0.22	13.75gh ± 0.01	1.18no ± 0.02
	1.5	29.15y ± 0.01	16.71abcde ± 0.36	13.30k ± 0.01	1.25jk ± 0.03
1	0	30.01t ± 0.01	16.50defgh ± 0.03	11.43r ± 0.01	1.44b ± 0.01
	0.25	30.16s ± 0.00	16.64bcdef ± 0.03	12.80n ± 0.10	1.30ef ± 0.01
	0.5	30.67q ± 0.01	16.54cdefg ± 0.08	13.78g ± 0.01	1.20mn ± 0.01
	1	30.01t ± 0.01	16.47defgh ± 0.20	13.83fg ± 0.01	1.19no ± 0.02
	1.5	29.78v ± 0.00	16.66bcdef ± 0.11	13.25k ± 0.03	1.26hij ± 0.01
2	0	30.16s ± 0.00	16.56cdefg ± 0.01	11.17t ± 0.12	1.48a ± 0.02
	0.25	30.96o ± 0.01	16.69abcdef ± 0.02	13.35k ± 0.02	1.25ijk ± 0.00
	0.5	31.09n ± 0.00	16.50defgh ± 0.15	13.65i ± 0.04	1.22lm ± 0.00
	1	30.74p ± 0.00	16.2 hi± 0.18	13.95de ± 0.02	1.16op ± 0.01
	1.5	29.91u ± 0.01	16.71 ± 0.14	13.13l ± 0.04	1.27ghi ± 0.01
3	0	31.41k ± 0.01	16.54cdefg ± 0.04	11.35rs ± 0.05	1.46ab ± 0.01
	0.25	31.22l ± 0.01	16.7abcde ± 0.01	13.54j ± 0.03	1.23jkl ± 0.01
	0.5	31.22l ± 0.03	16.74abcde ± 0.02	13.34k ± 0.04	1.26hijk ± 0.01
	1	31.18m ± 0.01	16.04l ± 0.03	13.95de ± 0.04	1.15pq ± 0.01
	1.5	30.03t ± 0.01	16.78abcd ± 0.16	13.09l ± 0.09	1.28efgh ± 0.02
4	0	31.82d ± 0.01	16.43efgh ± 0.02	11.30s ± 0.02	1.45ab ± 0.01
	0.25	31.69f ± 0.01	16.78abcd ± 0.01	13.67hi ± 0.03	1.23kl ± 0.00
	0.5	31.43k ± 0.01	16.64bcdef ± 0.03	13.32k ± 0.04	1.25ijk ± 0.00
	1	31.58j ± 0.01	16.04i ± 0.01	14.03cd ± 0.02	1.14pq ± 0.01
	1.5	30.55r ± 0.01	16.90ab ± 0.21	12.88mn ± 0.01	1.31e ± 0.02
5	0	32.12c ± 0.01	16.52cdefg ± 0.06	11.16t ± 0.12	1.48a ± 0.02
	0.25	32.11c ± 0.01	16.84abc ± 0.05	13.95de ± 0.06	1.21lmn ± 0.01
	0.5	31.67g ± 0.01	16.65bcdef ± 0.11	13.06l ± 0.04	1.28fghi ± 0.01
	1	31.61i ± 0.01	16.06i ± 0.04	14.31b ± 0.08	1.12q ± 0.01
	1.5	31.11n ± 0.01	17.00a ± 0.18	12.64o ± 0.03	1.35d ± 0.02
6	0	32.89a ± 0.02	16.37fgh ± 0.34	11.11t ± 0.15	1.47a ± 0.05
	0.25	32.85b ± 0.01	16.65bcdef ± 0.20	14.07c ± 0.02	1.18no ± 0.02
	0.5	31.75e ± 0.01	16.79bcd ± 0.13	12.95m ± 0.01	1.30efg ± 0.01
	1	31.74e ± 0.01	16.05i ± 0.06	14.85a ± 0.04	1.08r ± 0.01
	1.5	31.63h ± 0.01	16.95ab ± 0.14	12.51p ± 0.03	1.35cd ± 0.02

Mean ± SD Within columns, means followed by the same letter are not significantly different according to Duncan's (0.05).

3.2. Chemical Parameters:

The chemical parameters of tomato ketchup treatments with different concentrations of DPP are shown in Table 3. No difference in the total soluble solids content was noticed between ketchup treatments during the storage period. All samples had total soluble solids between 28.14–29.8. The present results agreed with those findings of Tabibloghmany and Ehsandoost (2013).

The pH values ranged between 4.86 ± 0.01 for control treatment at zero time and 4.68 ± 0.00 at the end of storage. Date pits treatments showed similarity with the control sample, which was 4.81 ± 0.00 at zero time and 4.71 ± 0.01 at the end of the storage for treatment 0.25%. On the other hand, treatment 1.5% recorded 4.61 ± 0.01 at zero time and 4.58 ± 0.01 at the end of storage. The slight decrease in pH values during the storage period may be due to various acids, such as phenolic acid. Moreover, oxidation of aldehydes and alcohols may produce various acids, which was affected by processing and storage temperature (Gould, 1992).

The pH values obtained are in accordance with Sharoba *et al.* (2005) and Nasir *et al.* (2014). On the other hand, Janette *et al.* (2007) reported that the pH of tomato ketchup was affected by thickening agents and ranged between 4.1 and 4.3 due to the quick increase of consistency. There was no significant difference in pH among the different thickened tomato ketchup during the storage. Slight increases of total titratable acidity results for tomato ketchup treatments were noticed and varied between 1.24 ± 0.01; 1.22 ± 0.01; 1.22 ± 0.02; 1.21 ± 0.01; 1.21 ± 0.01 at zero time and 1.32 ± 0.01; 1.28 ± 0.01; 1.29 ± 0.00; 1.28 ± 0.01; 1.29 ± 0.01 for concentrations 0; 0.25; 0.5; 1 and 1.5%, respectively. This is in agreement with Sharoba *et al.* (2005) and Torbica *et al.* (2016). Salt contents for tomato ketchup treatments were confined between 1.5 ± 0.01 and 1.7 ± 0.01.

Table 3: Chemical parameters of tomato ketchup treatments with different percentages of Khalas date pit powder.

Storage Time (Months)	Concentration (%)	Acidity	pH	%Nacl	Brix
0	0	1.24ijkl ± 0.01	4.86a ± 0.01	1.5j ± 0.01	28.41lm ± 0.01
	0.25	1.22no ± 0.01	4.81b ± 0.00	1.6g ± 0.01	28.24q ± 0.01
	0.5	1.22mno ± 0.02	4.75e ± 0.00	1.7a ± 0.01	28.21r ± 0.01
	1	1.21o ± 0.01	4.69n ± 0.01	1.6g ± 0.01	28.01u ± 0.01
	1.5	1.21no ± 0.01	4.61q ± 0.01	1.6g ± 0.00	28.00v± 0.00
1	0	1.25fghij ± 0.01	4.85a ± 0.01	1.51i ± 0.01	28.51hi ± 0.01
	0.25	1.23klmn ± 0.01	4.79c ± 0.01	1.61f ± 0.00	28.3p ± 0.02
	0.5	1.23jklm ± 0.01	4.74efg ± 0.01	1.7a ± 0.00	28.32o ± 0.01
	1	1.22no ± 0.01	4.67o ± 0.00	1.61ef ± 0.01	28.21r ± 0.01
	1.5	1.22lmn ± 0.01	4.60r ± 0.01	1.6g ± 0.00	28.14t ± 0.01
2	0	1.26efg ± 0.01	4.75ef ± 0.01	1.52h ± 0.00	28.55g ± 0.01
	0.25	1.24ijkl ± 0.01	4.77d ± 0.01	1.61ef ± 0.01	28.43k ± 0.01
	0.5	1.24ghij ± 0.01	4.74gh ± 0.01	1.7a ± 0.01	28.43k ± 0.01
	1	1.23klmn ± 0.01	4.65p ± 0.01	1.61ef ± 0.01	28.31o ± 0.01
	1.5	1.23jklm ± 0.01	4.60r ± 0.01	1.61ef ± 0.01	28.17s ± 0.01
3	0	1.26ef ± 0.01	4.71kl ± 0.01	1.52h ± 0.00	28.61f ± 0.01
	0.25	1.24hijk ± 0.00	4.74fg ± 0.00	1.61ef ± 0.01	28.51hi ± 0.01
	0.5	1.25fghi ± 0.01	4.73hi ± 0.00	1.69b ± 0.00	28.51hi ± 0.01
	1	1.23jklm ± 0.01	4.62q ± 0.01	1.62e ± 0.00	28.41lm ± 0.01
	1.5	1.24ghij ± 0.02	4.59s ± 0.01	1.63d ± 0.00	28.22r ± 0.01
4	0	1.28bcd ± 0.01	4.70m ± 0.01	1.52h ± 0.00	28.62f ± 0.01
	0.25	1.25fghij ± 0.01	4.74fg ± 0.00	1.62ef ± 0.01	28.52h ± 0.01
	0.5	1.26efg ± 0.01	4.73i ± 0.01	1.69b ± 0.00	28.52h ± 0.01
	1	1.24ijkl ± 0.01	4.62q ± 0.00	1.62e ± 0.00	28.42kl ± 0.01
	1.5	1.25 efgh± 0.01	4.59s ± 0.01	1.63d ± 0.00	28.22r ± 0.01
5	0	1.31a ± 0.01	4.69n ± 0.01	1.52h ± 0.00	28.86c ± 0.01
	0.25	1.27cd ± 0.01	4.73i ± 0.01	1.62ef ± 0.01	28.78e ± 0.01
	0.5	1.28bcd ± 0.01	4.72ij ± 0.01	1.69b ± 0.00	28.77e ± 0.01
	1	1.27de ± 0.01	4.60r ± 0.01	1.62e ± 0.00	28.48j ± 0,00
	1.5	1.27cd ± 0.01	4.58st ± 0.01	1.64c ± 0.00	28.37n ± 0.01
6	0	1.32a ± 0.01	4.68n ± 0.00	1.52h ± 0.01	28.99b ± 0.01
	0.25	1.28bcd ± 0.01	4.71lm ± 0.01	1.62e ± 0.00	28.8d ± 0.00
	0.5	1.29b ± 0.00	4.72jk ± 0.01	1.69b ± 0.00	29.8a ± 0.00
	1	1.28bc ± 0.01	4.58st ± 0.01	1.62e ± 0.00	28.5i ± 0.00
	1.5	1.29bc ± 0.01	4.58t ± 0.01	1.64c ± 0.00	28.4m ± 0.00

Mean ± SD within columns, means followed by the same letter are not significantly different according to Duncan (0.05).

3.3. Physical Parameters:

Physical parameters included bostwick, viscosity, hardness and adhesiveness for tomato–date pits ketchup (Table 4). Results indicated a high variation in viscosity for tomato–date pits ketchup ($P < 0.01$) in all treatments during storage. The control treatment for both rpm 50 and 100 was slightly decreased at the end of storage. On the other hand, tomato–date pits ketchup treatments (0.25% and 1.5%) increased viscosity at the beginning of storage and decreased at the end of storage. These increases in viscosity may be due to the destruction of pectolytic enzymes like pectinesterase, pectin oxidase and poly-galacturonase, which resulted in unhydrolysed polysaccharides like pectin and gums (Trifiro *et al.*, 1998). Ketchup viscosity and pectin substances were interdependent factors (Sanchez *et al.*, 2002; Koocheki *et al.*, 2009). This was due to higher water-binding capacity resulting from increasing fibre concentration, which had high viscosity. One of the essential targets for tomato ketchup quality by a consumer is its textural properties. The elevated scores of hardness and adhesiveness values were found in treatment 0.5% pits powder, compared with the control sample. Their bostwick values of tomato–date pits ketchup were higher than that of the control treatment during the storage period. A negative correlation between bostwick consistency and viscosity was found; this is consistent with Juszczak *et al.* (2013). Tomato ketchup incorporated with soybean fibre or 2% hydroxypropyl distarch phosphate had lower values of bostwick compared to the control (Li *et al.,* 2013) during the storage period. The firmness, consistency, cohesiveness and viscosity of thickened tomato ketchup increased as a result (Sit *et al.*, 2014). On the other hand, Tanglertpaibul and Rao (1987a and b)

reported that tomato concentrate's consistency was influenced by changes in soluble and insoluble solids.

Table 4: Physical parameters of tomato ketchup treatments with different concentrations of pits powder.

Storage Time (Months)	Concentration (%)	Bostwick	Visco50 rpm	Visco100 rpm	Hardness (g)	Adhesiveness (g.mm)
0	0	6.2^{lmj} ± 0.06	2956^{e} ± 0.6	1725^{z} ± 1.2	69^{n} ± 0.6	35^{w} ± 0.0
	0.25	9.1^{a} ± 0.06	3445^{a} ± 4.5	1987^{x} ± 1.7	109^{a} ± 0.6	57^{a} ± 1.2
	0.5	7.2^{g} ± 0.00	2702^{t} ± 4.0	1543^{w} ± 3.5	76^{t} ± 1.2	33^{t} ± 0.6
	1	6.6^{t} ± 0.06	2618^{x} ± 1.2	1505^{y} ± 5.1	83^{m} ± 0.6	23^{y} ± 0.6
	1.5	6.3^{p} ± 0.06	2982^{p} ± 2.9	1980^{y} ± 3.2	95^{p} ± 0.6	45^{p} ± 0.6
1	0	6.0^{v} ± 0.06	2868^{t} ± 0.6	1642^{z} ± 1.2	61^{x} ± 0.6	31^{g} ± 0.6
	0.25	9.0^{m} ± 0.06	3406^{m} ± 5.5	1786^{t} ± 3.1	88^{k} ± 0.6	42^{k} ± 0.6
	0.5	7.0^{m} ± 0.06	2557^{n} ± 1.7	1332^{q} ± 1.5	55^{z} ± 0.6	21^{xy} ± 1.2
	1	6.5^{rm} ± 0.06	2010^{w} ± 2.3	1502^{mw} ± 2.6	67^{v} ± 0.0	17^{yz} ± 0.6
	1.5	6.4^{lmn} ± 0.06	2664^{q} ± 2.3	1905^{z} ± 5.0	77^{s} ± 0.6	33^{tg} ± 0.6
2	0	5.9^{x} ± 0.06	2802^{g} ± 2.9	1592^{y} ± 2.9	56^{lpq} ± 0.6	28^{w} ± 0.6
	0.25	8.9^{e} ± 0.06	2988^{k} ± 0.6	1450^{x} ± 5.0	60^{w} ± 0.6	20^{lmn} ± 0.6
	0.5	6.9^{s} ± 0.06	2010^{w} ± 1.7	1135^{lm} ± 1.2	47^{y} ± 0.6	14^{q} ± 1.2
	1	6.4^{lmn} ± 0.06	1888^{lm} ± 1.2	1457^{z} ± 1.7	46^{lm} ± 0.6	13^{q} ± 0.6
	1.5	6.3^{mp} ± 0.00	2443^{lm} ± 2.1	1885^{x} ± 2.1	58^{lm} ± 0.0	21^{lmn} ± 0.6
3	0	5.8^{t} ± 0.06	2788^{rs} ± 1.2	1568^{x} ± 0.6	59^{z} ± 0.6	32^{g} ± 0.6
	0.25	8.8^{ef} ± 0.06	2273^{qr} ± 1.7	1284^{w} ± 2.9	58^{lmn} ± 0.6	21^{lmn} ± 1.2
	0.5	6.8^{t} ± 0.06	1828^{y} ± 0.6	1007^{y} ± 1.7	46st ± 0.6	13^{q} ± 0.6
	1	6.4^{lmn} ± 0.06	1625^{y} ± 1.7	911^{g} ± 1.2	46st ± 0.6	13^{q} ± 0.6
	1.5	6.2^{rq} ± 0.06	2183^{t} ± 5.2	1195^{w} ± 4.0	56^{rpq} ± 1.7	20^{lmn} ± 0.6
4	0	5.7^{w} ± 0.06	2503^{m} ± 2.6	1499^{mw} ± 1.0	65^{v} ± 0.6	36^{w} ± 0.6
	0.25	8.6^{e} ± 0.06	2004^{t} ± 5.8	1107^{y} ± 5.9	55^{qr} ± 0.6	21^{lmn} ± 0.6
	0.5	6.6^{t} ± 0.06	1668^{xy} ± 1.2	988^{lm} ± 1.2	45^{tw} ± 0.6	13^{qr} ± 1.2
	1	6.6^{w} ± 0.06	1334^{z} ± 0.6	906^{g} ± 5.3	44^{v} ± 1.2	12^{r} ± 0.6
	1.5	6.3^{mp} ± 0.00	1776^{w} ± 0.6	1099^{w} ± 1.2	57^{rlop} ± 0.6	19^{lmn} ± 0.6
5	0	5.5^{w} ± 0.06	2457^{lm} ± 1.7	1361^{t} ± 1.5	71^{lg} ± 0.6	33^{t} ± 0.6
	0.25	8.3^{t} ± 0.06	1888^{lm} ± 1.5	984^{lm} ± 3.1	57^{lmno} ± 0.0	28^{lm} ± 1.2
	0.5	6.4^{lmn} ± 0.06	1444^{z} ± 1.7	832^{w} ± 2.5	45^{tw} ± 0.6	16^{lp} ± 1.2
	1	6.7^{s} ± 0.06	1190^{w} ± 0.0	886^{t} ± 4.2	57^{lmn} ± 0.6	22^{lk} ± 0.6
	1.5	6.4^{lmn} ± 0.06	1555^{z} ± 1.7	996^{t} ± 4.0	66^{lm} ± 0.6	27^{t} ± 0.6
6	0	5.4^{w} ± 0.06	2362^{lm} ± 2.9	1317^{lm} ± 2.3	79^{lg} ± 0.6	32^{lg} ± 0.6
	0.25	8.2^{t} ± 0.00	1604^{z} ± 3.2	877^{lg} ± 2.1	60^{lm} ± 0.6	35^{lg} ± 1.2
	0.5	6.2^{lmj} ± 0.06	1250^{w} ± 2.9	711^{lg} ± 1.2	45^{tuv} ± 1.2	19^{lm} ± 0.6
	1	5.8^{lx} ± 0.00	1147^{z} ± 1.7	686^{lg} ± 1.2	59^{t} ± 0.6	26^{t} ± 0.6
	1.5	5.6^{v} ± 0.06	1437^{z} ± 1.2	809^{t} ± 1.5	68^{lm} ± 0.6	37^{lg} ± 1.2

Mean ± SD within columns, means followed by the same letter are not significantly different according to Duncan's (0.05).

3.4. Sensory Evaluation:

Sensory evaluation data of date pits tomato ketchup (Table 5) indicated no significant variations in water separation, texture, colour, or flavour of examined samples. However, the panellists did not recognise any difference between date pits ketchup compared to the control. The addition of date pits to ketchup enhanced texture quality, as the highest scores were observed in ketchup with 0.25% and 0.5%. Furthermore, the overall acceptance of tomato ketchup with 0.5% and 1% was significantly higher than other samples. It is important to determine a sensory and rheological adjustment for tomato ketchup supplemented with fibres to meet the desired needs criteria of different markets. Therefore, modification in viscosity, colour, or flavour according to customers' needs is required (Torbica *et al.*, 2016).

Table (5): Sensory evaluation of tomato ketchup treatments with different percentages of Khalas date pit powder.

Storage Time (Months)	Concentration (%)	Water Separation	Texture	Colour	Flavour	Overall
0	0	19.8^{abc} ± 0.42	15.7^{bc} ± 1.21	18.3^{abcde} ± 0.52	17.7^{def} ± 0.52	92.5^{efg} ± 2.17
	0.25	19.9^{ab} ± 0.20	17.7^{a} ± 1.03	19.5^{a} ± 0.55	19.7^{a} ± 0.52	96.0^{a} ± 1.55
	0.5	19.9^{ab} ± 0.20	18.2^{a} ± 0.75	19.3^{ab} ± 0.82	19.5^{ab} ± 0.55	95.3^{ab} ± 1.03
	1	19.8^{abc} ± 0.42	15.8^{bc} ± 1.17	18.3^{abcde} ± 0.52	18.2^{cde} ± 0.75	94.7^{abc} ± 1.63
	1.5	19.7^{abc} ± 0.52	15.0^{bc} ± 0.89	18.0^{cdef} ± 0.63	16.3^{ijk} ± 0.52	92.2^{efgh} ± 1.94
1	0	19.9^{ab} ± 0.20	15.3^{bcd} ± 0.82	18.0^{cdef} ± 0.63	17.5^{efg} ± 0.55	91.7^{fghi} ± 1.21
	0.25	19.9^{ab} ± 0.20	17.3^{a} ± 1.21	19.2^{ab} ± 0.75	19.5a^{b} ± 0.55	96.0^{a} ± 1.26
	0.5	19.9^{ab} ± 0.20	17.8^{a} ± 0.75	19.0^{abc} ± 0.89	19.3^{ab} ± 0.52	95.3^{ab} ± 0.52
	1	19.8^{ab} ± 0.26	15.3^{bc} ± 0.82	17.5^{efg} ± 0.55	18.0^{cde} ± 0.63	94.5^{abc} ± 0.84
	1.5	19.8^{ab} ± 0.41	14.5^{cde} ± 1.38	17.3^{efgh} ± 0.82	16.0^{ijkl} ± 0.00	93.5^{cde} ± 1.52
2	0	19.8^{ab} ± 0.26	15.2^{bcde} ± 0.75	17.8^{def} ± 0.75	17.2^{fgh} ± 0.41	91.3^{ghij} ± 1.21
	0.25	20.0^{a} ± 0.00	17.2^{a} ± 1.17	19.5^{a} ± 0.55	19.2^{ab} ± 0.41	94.2^{bcd} ± 0.41
	0.5	19.9^{ab} ± 0.20	17.7^{a} ± 0.52	19.3^{ab} ± 0.82	19.0^{abc} ± 0.63	93.5^{cde} ± 1.05
	1	19.9^{ab} ± 0.20	14.8^{bcdef} ± 0.75	17.2^{fgh} ± 0.75	17.5^{efg} ± 0.55	92.5^{efg} ± 0.55
	1.5	20.0^{a} ± 0.00	14.0^{efg} ± 0.89	16.3^{ijk} ± 0.52	15.8^{kl} ± 0.75	91.5^{ghij} ± 1.38
3	0	19.8^{ab} ± 0.42	15.2^{bcde} ± 0.75	17.5^{efg} ± 0.84	17.2^{fgh} ± 0.41	90.7^{hijk} ± 1.21
	0.25	20.0^{a} ± 0.00	17.2^{a} ± 1.17	19.3^{ab} ± 0.52	19.2^{ab} ± 0.41	92.8^{abc} ± 1.17
	0.5	20.0^{a} ± 0.00	17.5^{a} ± 0.55	19.0^{abc} ± 0.63	19.0^{ab} ± 0.89	91.2^{ghij} ± 1.17
	1	19.9^{ab} ± 0.20	14.3^{def} ± 0.82	16.7^{ghi} ± 0.52	16.8^{ghi} ± 0.75	90.8^{hijk} ± 0.75
	1.5	19.9^{ab} ± 0.20	13.7^{fg} ± 0.52	15.5^{hi} ± 1.22	15.8^{kl} ± 0.41	90.2^{ijk} ± 0.75
4	0	19.5^{abc} ± 0.55	14.8^{bcdef} ± 0.98	17.0^{fgh} ± 0.89	16.8^{ghi} ± 0.41	90.2^{ijk} ± 0.41
	0.25	19.8^{ab} ± 0.41	17.2^{a} ± 0.98	19.0^{abc} ± 0.63	19.3^{ab} ± 0.52	92.0^{efgh} ± 1.41
5	0.5	19.8^{ab} ± 0.41	17.0^{a} ± 0.89	18.7^{abcd} ± 0.82	18.7^{bcd} ± 1.03	91.0^{ghijk} ± 1.26
	1	19.5 ± 0.84	14.0^{efg} ± 0.63	16.5^{ghi} ± 0.55	16.7^{ghi} ± 0.52	90.2^{ijk} ± 0.41
	1.5	19.2 ± 1.33	13.0^{g} ± 0.63	15.2^{i} ± 0.98	15.5^{i} ± 0.55	89.5^{k} ± 1.22
6	0	19.0 ± 0.63	15.3^{bcd} ± 1.03	17.5^{efg} ± 0.84	17.2^{fgh} ± 0.41	91.0^{ghijk} ± 1.26
	0.25	19.8 ± 0.41	17.2^{a} ± 1.17	19.3^{ab} ± 0.52	19.2^{ab} ± 0.41	92.8^{abc} ± 1.17
	0.5	19.8 ± 0.41	17.5^{a} ± 0.55	19.0^{abc} ± 0.63	19.0^{ab} ± 0.89	91.2^{ghij} ± 1.17
	1	19.5^{abc} ± 0.84	14.3^{def} ± 0.82	16.7^{ghi} ± 0.52	16.8^{ghi} ± 0.75	90.8^{hijk} ± 0.75
	1.5	19.2^{bc} ± 1.33	13.7^{fg} ± 0.52	15.5^{hi} ± 1.22	15.8^{kl} ± 0.41	90.2^{ijk} ± 0.75
7	0	19.5^{abc} ± 0.55	15.3^{bcd} ± 0.82	17.2^{fgh} ± 0.98	16.5^{hijk} ± 0.84	91.0^{ghijk} ± 1.26
	0.25	19.7^{abc} ± 0.52	17.3^{a} ± 1.21	19.2^{ab} ± 0.75	19.0^{ab} ± 0.63	93.3^{bcde} ± 0.82
	0.5	19.7^{abc} ± 0.52	17.8^{a} ± 0.75	19.2^{ab} ± 0.75	18.8^{abc} ± 0.75	91.0^{ghijk} ± 1.26
	1	19.3^{abc} ± 0.82	15.3^{bcd} ± 0.82	16.5^{ghi} ± 0.55	16.7^{ghi} ± 0.52	90.7^{hijk} ± 0.52
	1.5	19.2^{bc} ± 1.33	14.5^{cdef} ± 1.38	15.3^{i} ± 1.03	15.5^{i} ± 0.84	89.8^{jk} ± 1.17

Mean ± SD within columns, means followed by the same letter are not significantly different according to Duncan's (0.05).

4. Conclusions

Date pits addition to ketchup enhanced texture quality, as the highest scores were observed in ketchup with 0.25 and 0.5 %. Furthermore, tomato ketchup's overall acceptability mixed with 0.5% and 1% was significantly higher than other samples. Ketchup properties with an increased nutritional value could be modified to meet consumers' health demands. The rheological results of date pits ketchup, compared to the control, showed possible replacement availability instead of other hydrocolloids or thickeners.

Bio

Nashi Khalid Alqahtani

Department of Food and Nutrition Sciences, College of Agricultural and Food Sciences, King Faisal University, Al Ahsa, Saudi Arabia
nalqahtani@kfu.edu.sa

Dr. Al-Qahtani holds a PhD degree in Food Science from RMIT University, Australia, 2017. He also obtained a master's degree in Food Science and Technology from RMIT University, Australia in 2011. He received a bachelor's degree in Food Science and Technology from the College of Agriculture and Food Science at King Faisal University in 2005. He is the Director of the Center for Supportive Studies and the Director of the Date Palm Research Center of Excellence, King Faisal University. He has published with the largest publishers worldwide, including nine articles in ISI- and/or Scopus-indexed journals and two papers in international conferences on food science.

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