Списание за наука
„Ново знание“
ISSN 2367-4598 (Online)
Академично издателство „Талант“
Висше училище по агробизнес и развитие на регионите - Пловдив

New Knowledge
Journal of Science
ISSN 2367-4598 (Online)
Academic Publishing House „Talent“
University of Agribusiness and Rural Development - Bulgaria

http://science.uard.bg

PREVENTING PHASE SEPARATION PROBLEM WITH NATURAL WAXES IN SESAME PASTE

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Abstract: The first aim of this study was to prevent phase separation in sesame paste and the second aim was to prepare spreadable sesame paste products. For this reason, commercially obtained sesame paste was supplemented with certain concentration of sunflower (1 and 3%) and beeswax (1, 3 and 5%). The samples were stored at 25 and 35°C for 21 days. Centrifugation stability, oil leakage, textural properties, viscosity and consumer test of the samples was analysed. The beeswax and sunflower wax added samples when compared with plain sesame paste (control) had lower oil leakage values. Viscosity measurement showed that control and beeswax (1 and 3%) added samples exhibited pseudo-plastic rheological behaviour. The textural measurements showed that sesame paste prepared with 3% sunflower wax was firmer and stickier than the sesame paste prepared with 1% sunflower wax and 5% beeswax. Additionally, the textural properties of the samples were significantly influenced by storage temperatures. Moreover, 1 and 3% sunflower and 5% beeswax added samples were spreadable while the 1 and 3% beeswax added samples were fluid. In conclusion, sunflower and beeswax addition were not only restricting phase separation in sesame paste, but also sesame paste was converted into spreadable form depending on the wax concentration.

Keywords: sunflower wax, beeswax, sesame paste, consumer test.

INTRODUCTION

Sesame (*Sesamum indicum L., Pedaliaceae*) is an annual plant growing in Africa, Asia and Europe. Sesame seeds, depending on cultivars, consist of important amounts of oil (50-60%), protein (18-28%), carbohydrates and ash (El Khier et al., 2008). Sesame seeds are regarded to be one of the most ancient vegetable oil sources. Sesame oil is resistant to oxidation due to its natural antioxidant content such as sesamin sesamolin, sesamol and tocopherols. Major fatty acids of sesame oil are 35,9–42,3% oleic acid, 41,5–47,9% linoleic acid, palmitic acid 7,9–10,2% and stearic acid 4,8–6,1%. Sesame seeds have unique balance of amino acids and contain Ca, Mg and Fe minerals. Due to the nutritional contents mentioned above, sesame seeds and sesame oil are designated as nutritive and healthy foods for humans (Arigul & Zorba, 2012; Bahkali et al., 1998; El Khier et al., 2008).

Sesame paste is produced by washing, peeling, roasting, crushing and grinding of the sesame seeds. Sesame paste is named as tahini and appears as colloidal suspension mainly composed of hydrophilic solids suspended in sesame oil. Sesame paste is nutritive and healthy food item that is resistant to chemical deterioration due to its antioxidant composition. Sesame paste is used as ingredient of bakery and confectionary products. Moreover, sesame paste is the main ingredient of the traditional desserts prepared with sesame paste and grape molasses (pekmez). Sesame paste can be also consumed as a spreadable product. One of the major problems concerning sesame paste is phase separation and this problem is the most important factor limiting consumption of sesame paste. As a result of phase separation not only consumer acceptance is negatively affected, but also manufacturers lose profits and reputation (Ciftci et al., 2008; Alpaslan & Hayta, 2002).

Previous studies have reported the restriction of phase separation/oil leakage from sesame paste and sesame paste based products such as tahini halva and tahini/pekmez blends. Alpaslan and Hayta (2002) reported that addition of pekmez improved the emulsion stability of the tahini/pekmez blends. Habibi-Najafi and Alaei (2006) reported that increasing the sugar concentration resulted in decrease of the oil leakage values of the tahini/sugar blends and the emulsion stability increased. Ciftci et al. (2008) reported that decreasing particle size improved the colloidal stability. Guneser and Zorba (2014) found out that sorbitan tristearate and sorbitan monopalmitate and their combinations decreased oil leakage in tahini halva. Ogutcu et al. (2017) reported that addition of natural waxes restricted oil leakage in tahini halva.

The primary objective of this study was to prevent phase separation in sesame paste and the secondary aim was to develop spreadable sesame paste products without sugar and grape molasses.

MATERIALS AND METHODS

Materials

Sesame paste samples were purchased from local manufacturers in Çanakkale province, Turkey. Sunflower and beeswax were purchased from KahlWax (Kahl GmbH & Co., Trittau, Germany). All other chemicals were of analytical grade and purchased from Merck (Darmstadt, Germany) and Sigma–Aldrich (St. Louis, ABD).

Sample Preparation

Firstly, sesame paste and sunflower wax (1 and 3%) and beeswax (1, 3 and 5%) were heated to 85-90°C in oil bath. Sesame paste was mixed with the completely melted waxes under isothermal conditions and the mixture was stirred at 15 000 rpm for 3 min and then the mixture was cooled at ambient conditions. The samples were stored at 25 and 35°C for 21 days for monitoring oil leakage.

Methods

Physico-chemical Properties

Protein, oil and ash contents of the samples were measured according to AOAC methods 945,2; 920,39 and 942,05 respectively. Colour values of the samples were measured using a Minolta CR-400 colorimeter (Konica Minolta Sensing, Osaka, Japan) with CIE lab standards. Released oil levels were determined using refrigerated centrifuge (Sigma 2-16KL) at 1 500 rpm for 5 min. Viscosity was measured with Brookfield Viscometer LVDV-II+ at 5, 10, 20, 50 and 100 rpm at 25 and 35°C and the results were expressed in cP. Textural properties (firmness, work of shear, stickiness and work of adhesion) were determined by using texture analyser TA-XT2i (Stable Microsystems, Surrey, UK) equipped with TTC Spreadability Rig (TA-425) and the results were expressed in N.

Sensory Analysis

The consumer tests were performed using 5- point hedonic scale (1- extremely dislike and 5- extremely like) that included five different features such as appearance, texture, spreadability, flavour and acceptability. The samples were selected for consumer test according to their physico–chemical, textural, and sensorial features. The Hedonic tests of the selected three sesame pastes were performed by 120 volunteer consumers who willingly consumed sesame paste or sesame paste based products.

Statistical Analysis

The present study was replicated two times and also, all measurements within each replicate sample were done at least twice. The parametric and non-parametric results were presented as means ± standard deviation (SD) and means ± standard error (Se), respectively. The values were considered statistically different when $p \leq 0.05$. The results were evaluated using Minitab 16.1.0 statistical software. The parametric data were evaluated by using ANOVA with Tukey's multiple tests to detect the differences between mean values, while for the non-parametric data Kruskall–Wallis test was applied to detect the differences between the median values of the samples.

RESULTS AND DISCUSSION

Some of the physico-chemical properties of the sesame paste samples are given in Table 1. According to Table 1, the L, a* and b* values of the samples ranged from 58,63-56,67; -0,39 – -0,29 and 16,34-15,67 respectively. The protein, oil and ash contents were in the ranges of 19,68–17,36; 36,17–25,66 and 2,59–1,84 respectively. In literature, reported chemical composition of sesame paste was 17-27% protein, 50-65% oil and 1,5-3,0% ash (Sawaya et al., 1985; Damir, 1984; Ozcan and Akgul, 1994; Lokumcu Altay and Ak, 2005; Ciftci et al., 2008). Literature findings are close to our findings, except for oil levels.

Table 1. Physico-chemical features of the sesame paste samples

Samples	L	a*	b*	Protein (%)	Oil (%)	Ash (%)
Control	56,67±0,09d*	-0,29±0,01a	16,35±0,01a	19,02±0,16ab	31,86±0,05c	2,31±0,02b
SW1	56,97±0,01cd	-0,29±0,01a	15,67±0,01d	18,15±0,50ab	30,89±0,30c	2,22±0,01bc
SW3	58,63±0,18a	-0,39±0,01b	15,88±0,01c	17,36±0,36b	25,66±0,62e	2,59±0,05a
BW1	56,8±0,01cd	-0,31±0,01a	16,29±0,01a	19,68±0,60a	36,17±0,09a	2,13±0,04c
BW3	57,44±0,01b	-0,39±0,01b	16,14±0,01b	18,19±0,05ab	32,98±0,04b	1,84±0,02d
BW5	57,13±0,04bc	-0,38±0,02b	16,13±0,04b	17,72±0,54b	29,30±0,07d	2,17±0,03c

**Small letters show differences among the samples in the same columns*

SW1: 1% added sunflower wax sesame paste, SW3: 3% added sunflower wax sesame paste, BW1: 1% added beeswax sesame paste, BW3: 3% added beeswax sesame paste BW5: 5% added sunflower wax sesame paste.

Sesame paste is a colloidal suspension containing sesame oil and hydrophilic particles. Sesame oil consists of mostly unsaturated fatty acids. Hence, the most frequent problem is phase separation. Figure 1 shows the phase separation degree of the plain sesame paste and wax added sesame paste samples. The higher released oil values were observed for the control sample (28,4%) and the lower released oil levels were for the sunflower wax added samples (14,15-17,53%). In terms of released oil levels, the control and beeswax added samples were found similar, while sunflower wax added samples were significantly different (p<0,05).

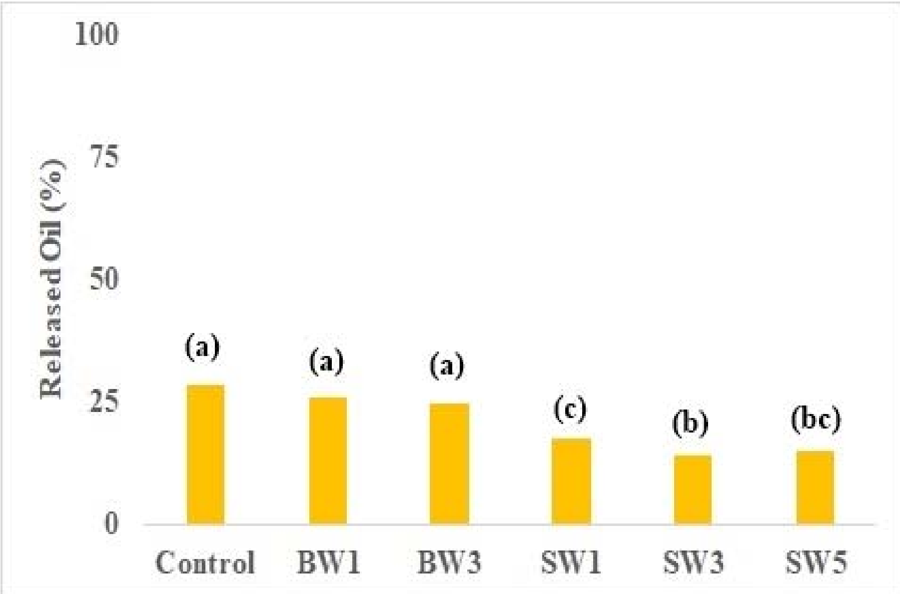


Figure 1. Centrifuge stability of the sesame paste samples*

**Small letters show differences among the sesame paste samples in terms of released oil.*
SW1: 1% added sunflower wax sesame paste, SW3: 3% added sunflower wax sesame paste, BW1: 1% added beeswax sesame paste, BW3: 3% added beeswax sesame paste BW5: 5% added sunflower wax sesame paste.

1 and 3% beeswax added samples were observed in liquid form, while 5% beeswax and 1 and 3% sunflower wax added sesame paste samples were in spreadable (semi-solid) form (Figure 2 and 3).

Thus, the viscosity of the control and beeswax (1 and 3%) added samples were determined. The viscosity values of the samples are given in Figure 4. Addition of beeswax increased the viscosity of the sesame paste depending on the wax addition levels. On the other hand, the viscosity of the control sample was affected by measurement temperature though wax added samples were not affected. Viscosity measurement revealed that control and beeswax (1 and 3%) added samples showed pseudo-plastic rheological behaviour. Alpaslan and Hayta (2002) reported that sesame paste/pekmez blends exhibited pseudo-plastic behaviour.

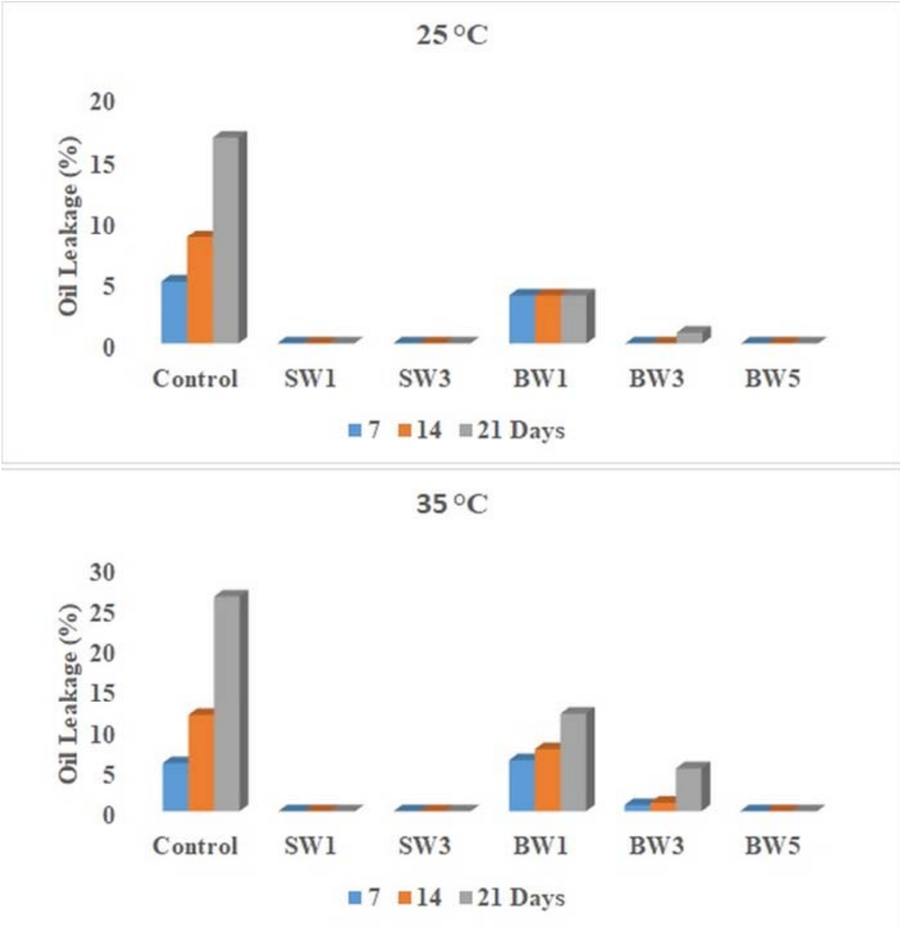


Figure 2. Oil leakage values of the sesame paste samples stored at 25 and 35°C

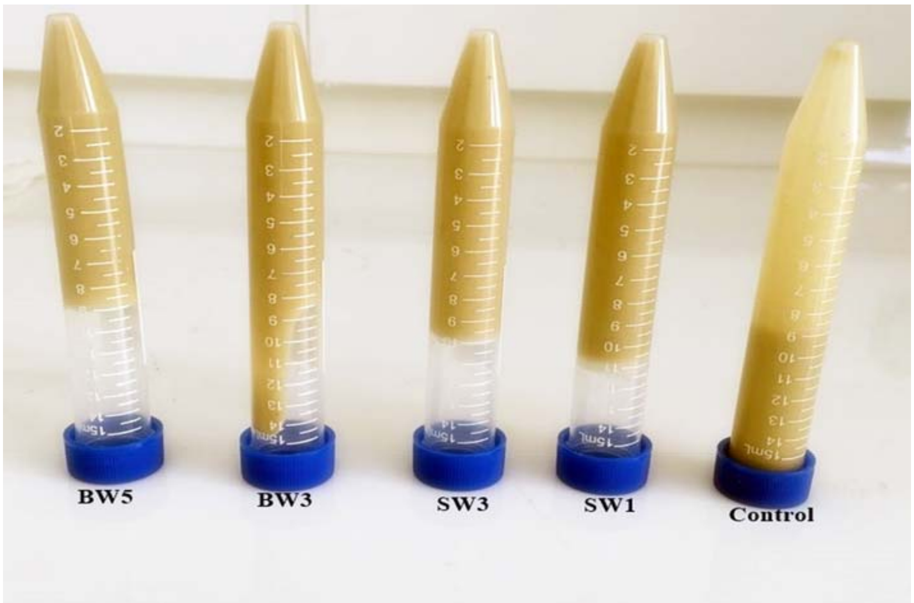
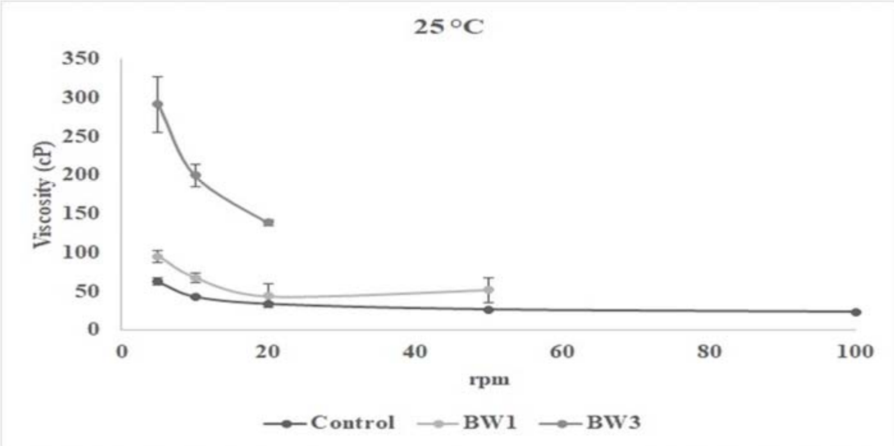


Figure 3. The sesame paste samples prepared with sunflower wax and beeswax
SW1: 1% added sunflower wax sesame paste, SW3: 3% added sunflower wax sesame paste, BW3: 3% added beeswax sesame paste BW5: 5% added sunflower wax sesame paste.



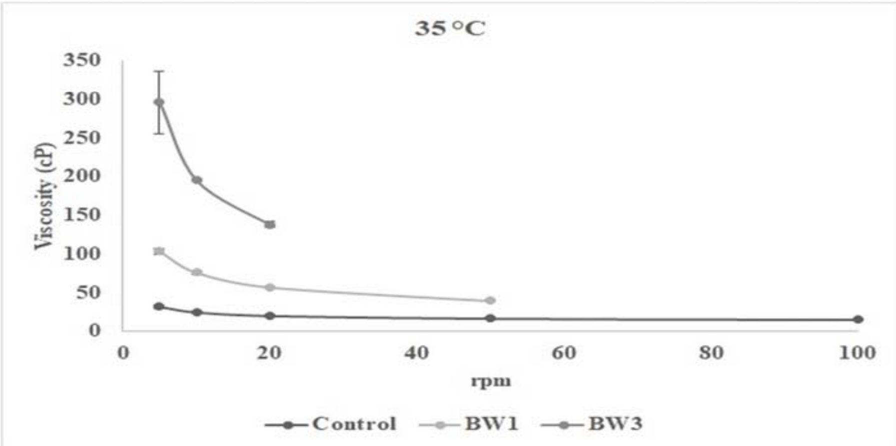


Figure 4. Viscosity measurements of the sesame paste samples.
BW1: 1% added beeswax sesame paste, BW3: 3% added beeswax sesame paste

The textural properties of the spreadable sesame paste samples are given in Table 2. The textural measurements showed that sesame paste prepared with 3% sunflower wax was firmer and stickier than the sesame paste prepared with 1% sunflower wax and 5% beeswax. Additionally, the textural properties of the samples were significantly influenced by storage temperature, wax addition level and wax types ($p<0,05$).

Table 2. Textural properties of the sesame paste samples stored at 25 and 35°C

	Firmness (N)		**Work of Shear (N)**	
	25°C	**35°C**	**25°C**	**35°C**
SW1	338,67±2,65c*	528,32±24,75b	219,06±4,75c	448,51±22,84b
SW3	1352,83±69,08a	2781,76±130,23a	1141,58±90,75a	2766,55±56,59a
BW5	1055,78±28,39b	910,34±6,15b	877,81±61,38b	757,05±19,10b
	Stickiness (N)		**Work of Adhesion (N)**	
	25°C	**35°C**	**25°C**	**35°C**
SW1	484,05±5,89c	714,86±37,78b	82,45±0,28c	140,57±4,60b
SW3	1595,35±44,27a	3173,04±112,16a	404,62±20,37a	711,90±37,94a
BW5	1372,75±64,12b	1092,05±76,69b	277,28±23,13b	211,62±23,77b

**Small letters show differences among the samples in the same columns*
SW1: 1% added sunflower wax sesame paste, SW3: 3% added sunflower wax sesame paste, BW5: 5% added sunflower wax sesame paste.

The hedonic scores of the sesame paste samples are given in Figure 5. The sesame paste samples were evaluated in terms of five features such as appearance, texture, flavour, spreadability and acceptability with up to 120 volunteers who consume sesame paste. In terms of flavour features, there were no differences among the samples. Especially the food additives should have some properties such as being nontoxic, cheap and not negatively affecting sensory. These results proved that wax additions did not negatively affect sesame flavour. In terms of appearance, texture, spreadability and acceptability features of the sesame paste samples, there were statistically significant differences among the samples. The sunflower wax added samples had higher sensory scores than the beeswax added and control samples. Additionally, the beeswax added sesame paste samples had higher scores than the control samples. These results demonstrated that wax added sesame paste samples were more desirable than the control samples according to consumers.

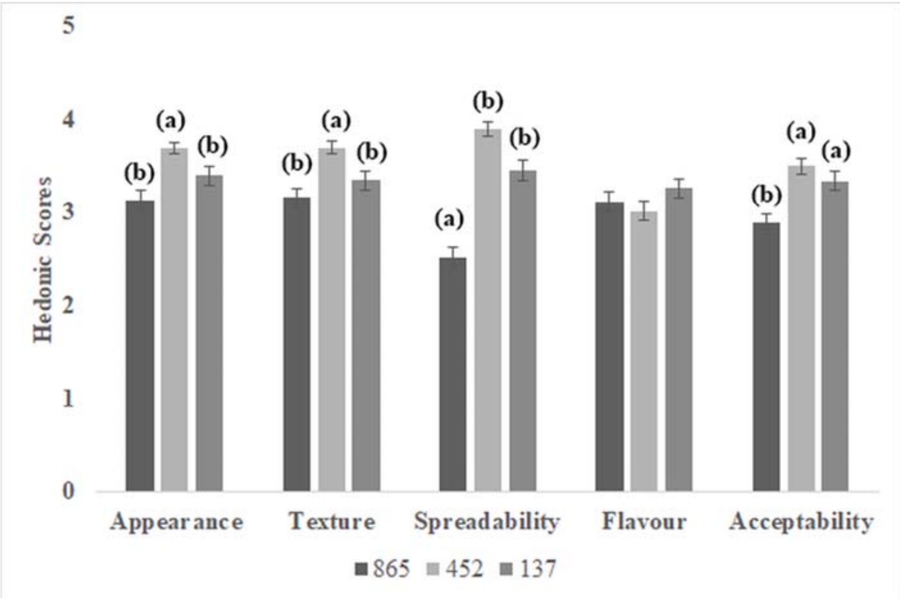


Figure 5. Hedonic scores of the wax added and control sesame paste samples*
**Small letters show differences among the sensory features of the sesame paste samples.*
BW1: 1% added beeswax sesame paste, BW3: 3% added beeswax sesame paste

CONCLUSION

In conclusion, natural waxes addition was effective to restrict the phase separation, hence, prolonged shelf life of sesame paste. Due to the prolonged shelf life of the sesame paste not only consumer preferences are not negatively influenced, but also the manufacturers and dealers will not lose their reputation, economics and product quality. The other important results of the present study are that sesame paste is converted to spreadable product with natural wax addition depending on the addition level. For this reason, it is considered that there is a potential for commercialization as a new functional product. In this context, further research on the subject is carried out by our research group.

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