https://doi.org/10.61308/BXLO9449

Investigation of stability characteristics of emulsions with (*Ziziphus jujube Mill.* Oil) water and oil phase vegetable sunflower oil 20, 40 and 60%

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Citation: Petkova, T., Goranova, Zh., Tranenska, P., Petrova, T., & Manev, Z. (2025). Investigation of stability characteristics of emulsions with (*Ziziphus jujube Mill*. Oil) water and oil phase vegetable sunflower oil 20, 40 and 60%. *Bulgarian Journal of Crop Science*, *62*(2) 104-110

Abstract: The stability characteristics of model emulsions O/W with stabilizer 20% dry matter from four varieties of *Ziziphus jujube* (Tiger tooth, Li (with and without spines), China 2A) of Bulgarian origin were studied. The stability characteristics of the varieties during storage (first, fifth, tenth day) were investigated. Basic emulsion characteristics (stability, dispersity and distribution of oil globules) were analyzed. Increasing the oil phase from 20 to 40 and 60% increased the stability of the emulsions systems in the storage process. Dispersity increases with increasing oil phase (20, 40 and 60%). Microscopic studies prove the analysis of the stability characteristics made. Good stability properties were established for all four jujube varieties of Bulgarian origin.

Keywords: jujube; Bulgarian origin; stability characteristics

INTRODUCTION

Hernandez et al. (2016), Wojdylo et al. (2016), Cosmulescu et al. (2018), Pu et al. (2018) investigated the physicochemical and biochemical properties of jujube (*Ziziphus jujube Mill*.). The fruits of *Ziziphus jujube* contain very valuable macronutrients for the human body (proteins, fats, carbohydrates). Of greatest interest to researchers are carbohydrates (sugars, dietary fiber and pectin). Pareek & Dhaka (2008), Gao et al. (2011), Pareek (20013) found out the quantitative pectin content of *Ziziphus jujube* fruits grown in China was higher compared to *Malus domestica* (local apple). The high content of pectin in the fruits of *Z. jujube* arouses interest in their use in culinary desserts, creams, soufflés, puddings (Guo et al., 2010; Ren et al., 2012; Yan et al., 2014). Ren et al. (2012), Yan et al. (2014) found high pectin content in *Ziziphus jujube* (3.8% for fresh fruit), which defines jujube as a suitable stabilizer in food emulsions. In recent years, special interest has been shown in the functional characteristics of Z. *jujube* applicable in the production of emulsion products (Wang et al., 2014; Moradinezhad et al., 2016; Xie at al., 2017; Pu et al., 2018). Because of the high nutritional values of sugars, fatty acids, minerals, vitamins, polyphenols and other antioxidants *Ziziphus jujube* has been defined as a functional food (Li et al., 2007; Gao et al., 2011; Wang et al., 2014; Hernández et al., 2016). There is ample scientific evidence that consumption of *Ziziphus jujube* has health benefits (Pareek & Dhaka, 2008; Wang et al., 2014;

Hernández et al., 2016). The cytotoxicity of triterpene acids extracted from *Z. jujuba* fruits have been studied in vitro on tumor cells (Lee et al., 2003; Eiznhamer & Zu, 2004; Liu et al., 2004). Scientists have reported (Sarfaraz et al., 2002) the antifungal effects of *Z. jujuba*. On *Candida albicans, C. tropicalis, Aspergillus flavus, A. niger* and *Malassezia furfur* (strains 1374 and 1765). Anti-inflammatory and significant antispastic or antispasmodic effect was investigated in 2004 by Shiv et al. High antiallergic activity of *Z. jujuba* proves Su et al. (2002). Wang et al. (2014) suggested that oleamide, a component of *Z. jujuba* fruit extract, may be a useful chemo preventive agent against Alzheimer's disease. Scientists believe that *Z. jujuba* contributes to hypotensive and antinephritic effects, possibly by increasing renal blood flow (Ganachari et al., 2004; Ren et al., 2012; Pareek, 2013). *Z. jujuba* fruit extract has been reported to stimulate the chemotactic, phagocytic and intracellular killing potential of leukocytes (Ganachari et al., 2004). Researchers from South Korea (Lee et al., 2003; Ko et al., 2008) comprehensively reviewed 70 antioxidant Korean medicinal plants, confirming the antioxidant effect of *Z. jujuba* (in vitro).

MATERIALS AND METHODS

Four cultivars of *Z. jujube* Li (with and without spines) China 2A, Tiger‘s Tooth were studied. Jujube fruits (*Ziziphus jujube Mill.*) are of Bulgarian origin, Blagoevgrad region. After they were sorted, washed, and dried, in a thin layer, they were frozen at -18°C. The thawed fruits were crushed and water was added to obtain a solution with 20% jujube dry matter. Food emulsions of the O/W type were studied. For the oil phase, vegetable sunflower oil „Kaliakra - first press" was used, produced by Bunge Romania S.R.L., Romania. The emulsion systems were prepared on a B-500/20F homogenizer. With a homogenization time of 5 minutes. The obtained samples are examined immediately after their preparation (first day) and in the process of storage (5th and 10th day of production). The pectin content of four jujube cultivars (Tiger Tooth, Li, Li (thornless) and China 2A) was investigated. Analysis of the polyuronide content (PUS) of the pressings 2 samples of 2 g each of the pressings are weighed on the analytical balance (accurate to the fourth digit), 2 g of NaCl and 150 ml of distilled H_2O are added each. The samples are stirred for 2 hours on an electric stirrer. They are washed with 50 ml of distilled H_2O. Two blank samples (200 ml distilled. H_2O and 2 g NaCl) are made in parallel. 5 drops of Hinton‘s reagent are added to each of the samples and titrated with 0.1 n NaOH, while shaking. 40 ml of 0.1 N NaOH was added and the samples were allowed to stand for 2 hours. Then 50 ml of 0.1 NH_2SO_4 were added. Titrate with 0.1 N NaOH.

$$PUS = \frac{(Ml\,1 - st\ titr.F.\,0{,}01761) + (Ml\,2 - nd\ titr.F.\,0{,}01901)}{g}.\,100$$

F is the factor of 0.1 N NaOH

g amount of sample

Extinction (%) was measured on a Spekol 11 Carl Zeiss spectrophotometer according to the method of Govin & Leeder (1971). Microscopic analysis was performed on an LCD Digital Microscope II Celestron, eyepiece 20x40 (Barnett & Timbrell, 1962; DeMan, 1982). The stability of the emulsions was determined by the method of Kozin (1950) on a Nahita Model 2640/12 centrifuge

RESULTS AND DISCUSSION

The polyuronide content of four jujube varieties of Bulgarian origin was determined.

With the highest and closest polyuronide content are Li and China 2A varieties followed by Tiger Tooth and Li (thornless), with values 2,74 of China 2A being 19% higher than those of Li (thornless). The high polyuronide content of the studied jujube varieties determines the possibility of their use as a stabilizer in food emulsion systems of the O/W type. Based on the literature review (Pareek & Dhaka, 2008; Pareek, 2013; Moradinezhad et al., 2016; Xie at al., 2017), we aimed to investigate the stabilizing properties of polyuronide acids in food emulsions O/W

Table 2 shows the recipe composition of model emulsions of 20% dry content of four jujube varieties of Bulgarian origin and 20, 40 and 60% oil phase (OF).

A technological scheme for obtaining model emulsions with four jujube varieties Tiger tooth, Li (with and without spines) and China 2A (20% dry matter) and OF vegetable sunflower oil (20, 40 and 60%) was developed (Figure 1).

Main emulsion characteristics (stability, dispersity and oil globule distribution) of food emulsions with jujube stabilizer, Tiger Tooth, Li (with and without spines), China 2A (20% solids) and OF vegetable sunflower oil (20, 40 and 60%) in the process of storage for first, fifth and tenth days. In Table 2 the results of the emulsion stabil-

Table 1. Polyuronide content of four varieties of *Z. jujube*

Variety *Z. jujube Mill*	Pectin (fresh fruit), %
Tiger tooth	2,56
China 2A	2,74
Li	2,67
Li (thornless)	2.22

Table 2. Composition of model emulsions with stabilizer 20% dry content of Tiger tooth, Li (with and without spines), China 2A and OF (20, 40 and 60%)

Variety *Z. jujube Mill,* 20%	Oil phase, % (vegetable oil)	Dispersion medium, % (water)
Tiger tooth	20	80
	40	60
	60	40
Li	20	80
	40	60
	60	40
Li (thornless)	20	80
	40	60
	60	40
China 2A	20	80
	40	60
	60	40

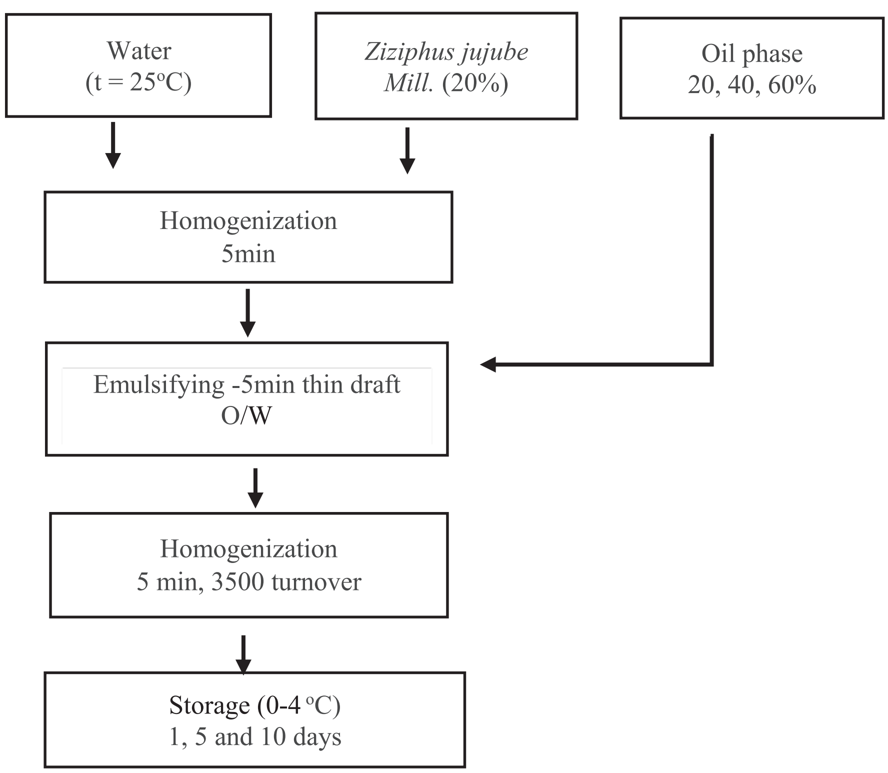


Figure 1. General technological scheme for obtaining O/W model emulsions

ity (%) of the model emulsions are given. Emulsion stability values are close to 100%. For all model emulsions, a decrease in emulsion stability was observed in the storage process (regardless of the amount of OF), with sedimentation processes being stronger for Li (thornless) and Tiger tooth. The results obtained for 20% OF emulsions confirm the values from the Table 3.

The dispersity of O/W emulsions with stabilizer 20% dry content of Tiger tooth, Li (with and without spines), China 2A and OF (20, 40 and 60%) was determined, and the extinction values (E, %). The results are presented in Table. 4. Extinction values increased with increasing oil phase from 20 to 40%. The emulsions with the Tiger tooth variety and 40% OF are the most dis-

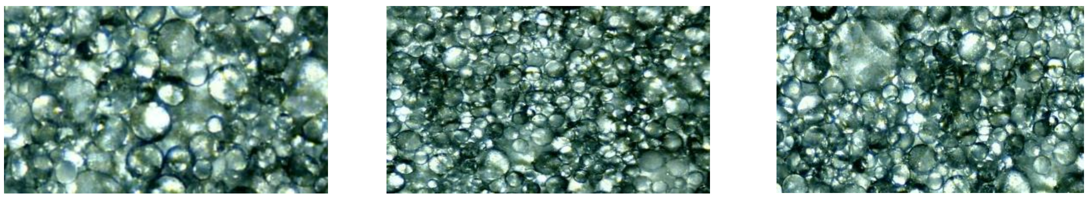
Table 3. Stability of model emulsions, in the process of storage 1st, 5th and 10th days

Ratio stabilizer. /OF	Preserved emulsion, % first day	Preserved emulsion, % fifth day	Preserved emulsion, % tenth day
Tiger tooth 20/20	92,35,00	92,15	89,17
Li 20/20/	88,00	85,00	82,78
Li (thornless) 20/20	74,00	71,00	67,32
China 2A 20/20	76,10	75,89	73,90
Tiger tooth 20/40	100	98,95	95,66
Li 20/40	89,50	86,73	84,95
Li (thornless) 20/40	76,20	72,48	68,10
China 2A 20/ 40	86,05	82,31	78,24
Tiger tooth 20/60	89,72	85,27	83,18
Li 20/60	93,42	88,88	82,60
Li (thornless) 20/60	76,77	72,31	68,14
China 2A 20/60	100,00	97,30	93,20

Table 4. Extinction of model emulsions, in the process of storage 1st, 5th and 10th days

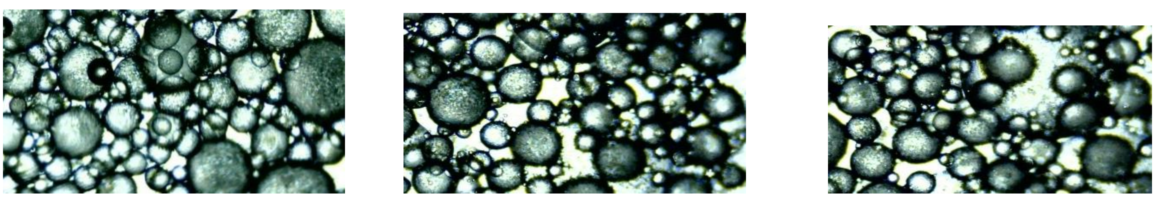
Variety/ OF	E, % first day	E, % fifth day	E,% tenth day
Tiger tooth 20/20	0,033	0,010	0,054
Li 20/20/	0,032	0,009	0,074
Li (thornless) 20/20	0,018	0,038	0,071
China 2A 20/20	0,022	0,47	0,077
Tiger tooth 20/40	0,040	0,013	0,057
Li 20/40	0,034	0,011	0,079
Li (thornless) 20/40	0,019	0,042	0,073
China 2A 20/ 40	0,025	0,053	0,079
Tiger tooth 20/60	0,026	0,009	0,048
Li 20/60	0,027	0,007	0,070
Li (thornless) 20/60	0,015	0,034	0,069
China 2A 20/60	0,018	0,047	0,073

persed, on the tenth day of storage. Emulsions are preserved in terms of stability and dispersibility for up to 10 days with high values. The problem is the appearance of molds in the storage process after the fifth day. It is evident from the tables that with the addition of Tiger tooth, Li (with and without spines), China 2A. the extinction of emulsion systems increases, and this is most pronounced at OF 40%. The distribution of oil globules in model emulsions with stabilizer 20% dry content of Tiger tooth, Li (with and without spines), China 2A and OF vegetable sunflower oil (20, 40 and 60%) was determined by microscopic analysis. As the OF concentration increases, the fine dispersity of the emulsions increases (Figs. 2, 3, 4 and 5).



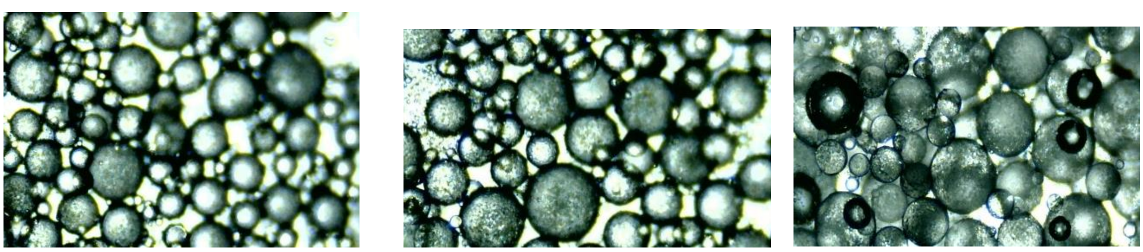
A) B) C)

Figure 2. Microscopic analysis of the distribution of oil globules in model emulsions with stabilizer 20% dry content of Tiger tooth, and OF vegetable sunflower oil 20% (A), 40% (B) and 60% (C)



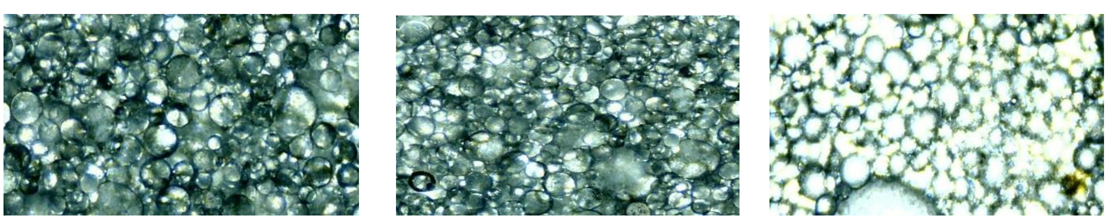
A) B) C)

Figure 3. Microscopic analysis of oil globule distribution in model emulsions with stabilizer 20% dry content of Li, and OF vegetable sunflower oil 20% (A), 40% (B) and 60% (C)



A) B) C)

Figure 4. Microscopic analysis of the distribution of oil globules in model emulsions with stabilizer 20% dry content of Li (thornless), and OF vegetable sunflower oil 20% (A), 40% (B) and 60% (C)



A) B) C)

Figure 5. Microscopic analysis of oil globule distribution in model emulsions with stabilizer 20% dry content of China 2A, and OF vegetable sunflower oil 20% (A), 40% (B) and 60% (C)

CONCLUSION

The stability characteristics of model emulsions O/W with stabilizer 20% dry matter from four varieties of jujube (Tiger tooth, Li (with and without spines), China 2A) were investigated. The obtained results present valuable information about the stability characteristics of varieties of Bulgarian origin, in the process of storage (first, fifth, tenth day). The results show that increasing the oil phase from 20 to 40 and 60% increases the stability of the emulsion systems in the storage process. Dispersity increases with increasing oil phase (20, 40 and 60%). The microscopic studies made prove the analysis of the stability characteristics made. Good stability properties were established for all four varieties of jujube of Bulgarian origin from the region of Blagoevgrad.

Conflict of interest: We declare no presence of a conflict of interest.

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Received: December, 15, 2024; Approved: February, 22, 2025; Published: April, 2025