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RESEARCH ARTICLE

THE POSSIBILITY OF USING JOJOBA SAFE EXTRACT AS NATURAL FOOD PRESERVATION

***,[1]Makpoul, K. R. and [2]Ibraheem, A. A.**

[1]Food Science and Technology, Agricultural Industrialization Unite
[2]Department of Plant Production, Desert Research Center, Cairo, Egypt

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ABSTRACT

The influence of crude aqueous extract of jojoba meal and leaves with simmonds in (MS and LS) and without simmonds in (MS^{-1} and LS^{-1}) at several concentrations on Physio chemical, microbiological and sensory characteristic of mango drink through storage was assessed. The inhibitory effect of Jojoba extract was tested as a preservative and its effect on the chemical components and sensory properties of the mango syrup prepared by simulating the industrial method and storing it at room temperature for 180 days. Protein and fat decreased while ash content and total soluble solid (TSS) increased during storage. A slight slight decrease in pH was observed with a relative increase ($p < 0.05$) in the acidity of stored pulp samples. Significant inhibition of total bacterial count (TBC) was observed on the application of the specific concentration. Storage time significantly increased the CFU/ml of drink samples as maximum growth was observed after 180 days of storage. The sensory properties of the mango pulp samples were adversely affected by the addition of preservatives, but the samples were accepted by the judges even after six months of storage.

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INTRODUCTION

Nutritional quality of food products has affected food spoilage and food-borne pathogens which has a direct by consuming of chemical composition, biochemical changes and toxicity, in addition of their adverse economic consequences. Microbial contaminants are able to produce some danger toxic as secondary metabolites, like mycotoxins, that are capable of causing disease and death in humans (You, 2006). In food industry including many preservation methods were used as low-temperature storage, vacuum package, irradiation… but the use of chemical preservatives are most employed method in agroindustry. However, the safety problems related to the use of chemical preservatives are receiving growing attention. Therefore, many research teams have focused on the development of safety preservation procedures using naturally derived substances such as salt, sugars, vinegar and natural extracts from dietary plants. The richness of these dietary plants on phenolic compounds such as tannins and flavonoids, known for their several biological effects including antimicrobial properties, can have a direct impact on reducing the health hazards and economic losses due to food-borne pathogens (Feten *et al*, 2014). Natural plants have a high potential for producing The most important of bioactive constituents, which are mainly secondary metabolites, such as alkaloids, saponin, flavonoids, tannins and phenolic compounds. These phytochemicals could be toxic to microbial cells (Dash *et al*, 2008). Simmondsiachinensis (jojoba) is a semiarid evergreen shrub. It develops wild in the desert south-western United States and north-western Mexico. Though, the plant is cultivated in some of the Middle East and Latin American countries (Borlaug *et al*., 1985; Bellirou *et al*., 2005). Jojoba seeds contain about 50–60% of a unique wax ester oil which is composed mainly of straight chain monoesters in the range of C40–C44 (Ellinger *et al*., 1973). Jojoba oil has good markets in the cosmetics and lubricant industries (Cokelaere *et al*., 1992a), and newly, it has been informed that the jojoba seeds have anti-inflammatory activity (Habashy *et al*., 2005). Next oil taking out of jojoba seeds, a protein rich residue remains, known as defatted jojoba meal. The meal contains 20–32% of protein, consisting largely of albumins (79%) and globulins (21%) (Shrestha *et al*., 2002). This meal also contains approximately 15% of a group of glucosides, known as simmondsins (Ellinger *et al*., 1973; Van Boven *et al*., 2000). Eight glucoside compounds (simmondsin and seven simmondsin derivatives) have been isolated and identified form jojoba seeds (Bellirou *et al*., 2005). Among these the methylated compounds simmondsin and simmondsin 2_-ferulate exhibited food-intake inhibition in rodents and chickens. In our search of the literature we have found no studies on the bioactivity of extracts and glucosides isolated

******Corresponding author:* **Makpoul, K. R.**
Food Science and Technology, Agricultural Industrialization Unite

from jojoba against food spoilage (Moustafa *et al*., 2007). Besides Jojoba seeds and meal have been shown to contain considerable amounts of tannins (2.5%) (Wiseman, 1987 a, b). In addition, Jojoba contains anthocyanins namely malvidin (Sharp, 1974), alkaloids (Hultin, 1966), while the leaves contain two major flavonoids which are isorhamnetin 3-rutinoside (narcissin) and isorhamnetin 3, 7-dirhamnoside (Orwa *et al*., 2009). Originally, it was believed that the jojoba plant was toxic because of the presence of simmondsin. It was stated that the -CN part would give rise to HCN in the body when digesting the simmondsin compound (Booth *et al*., 1974; Verbiscar *et al*., 1980; Williams, 1980), thus leading to emaciation. Meanwhile, it has been proven that digestion of simmondsin does not lead to liberation of cyanides into the body (Cokelaere *et al*., 1992b), but rats fed with 3% de-oiled jojoba flour still showed a lower weight gain than the pair-fed animals (Cokelaere *et al*., 1993). In 1980, Verbiscar *et al*. reported that five mice died when fed simmondsin at 750 mg/kg for 14 days and three surviving mice showed signs of hepatotoxicity and possible intestinal hemorrhage. Intraperitoneal administration of the same dose, however, did not decrease body weight of rats nor were there any other drug-induced effects. Subsequent pair-feeding studies, using more moderate levels of simmondsin, suggested that its effects are primarily because of decreased voluntary food consumption. Rats fed 250 mg/kg for 5 days showed no toxicological influences on biochemical parameters of the liver, pancreas and kidneys and no pathological changes were found in kidney, liver, pancreas, stomach, intestine, testis and seminal vesicle (Moyad, 2014). The LD50 of the aqueous extract of Simmondsiachinensis was 4.14 g kg-1 bodyweight, method which represents 20.54 g of crude powdered plant material for 1 kg body weights (Litchfield and Wilcoxon, 1949).

The aim of the present investigation is to achieve the effective utilization of water extracts of jojoba leaves and jojoba defatted meal for food preservation.Determine total polyphenol, simmondsin, and tannin contents at (leaves, and defatted meal) of jojoba. Chemical preservatives are being replaced with water extracts from jojoba leaves and defatted meal. Therefore, the biological activity of the extracts will be studied. Several concentrations of water extract, evaluated as food preservation in mango juice during storage. followed by investigated to the antimicrobial effect of the different concentrations of water extract. determine the effect of simmondsin in food preservation.

MATERIALS AND METHODS

Plant material preparation

Jojoba defatted meal and leaves were obtained from Middle Sinai research station (El Maghara in Sinai)- desert research center-Egypt. The defatted mealsamples were ground to pass through a 60-mesh sieve using an analytical mill to fine powder. Jojoba leaves were dried at 50°C then ground to pass through a 60-mesh sieve using an analytical mill to fine powder. Mango fruit was obtained from the local market of Egypt. Thefruit was carefully washed to take out dirt, dust, pesticide and residues on the surface of the fruit.

Preparation of Extracts

The fine powdered samples (20g) of defatted meal and leaves were extracted with 100 ml of boiling water until cooled, then saved at room temperature for 24 h and filtered using Whatman No. 1 filter paper. This crude extracts with simmondsin were labeled as (MS) for meal with simmondsin and (LS) for leaves with simmondsin. For extracts without simmondsin the fine powdered samples (20g) of defatted meal and leaves were extracted with 100 ml of acetoneand water (80:20, (v/v)) for 24 h at (25°C). After filtered The residues of defatted meal and leaves were extracted with 100 ml of boiling water until cooled, then saved at room temperature for 24 h and filtered using Whatman No. 1 filter paper. This crude extracts without simmondsin were labeled as (MS^{-1}) for meal without simmondsin and (LS^{-1}) for leaves without simmondsin.

Determination of phenols, tannins and simmondsins in extracts

Total phenols were determined with the Folin-Ciocalteau reagent (Makkar *et al*., 1993, and Makkar 2003). Extractable tannins were determined as the differences in total phenols (measured by Folin-Ciocalteau reagent) before and after treatment with insoluble polyvinyl polypyrrolidone (PVPP), as this polymer binds strongly to tannins (Makkar *et al*., 1995). Total phenols TP and total tannins (TT) TT were expressed as tannic acid equivalents. Condensed tannins were measured by the HCl-butanol method and results were expressed as leucocyanidin equivalent (Makkar, 2003).Simmondsins were determined in the defatted jojoba meal and jojoba leaves extracts using HPLC apparatus with a L-6200 pump (Merck-Hitachi, Germany) equipped with a L-3000 photo diode array detector (Merck-Hitachi, Germany). Total simmondsins (TS)determined as summation of (Simmondsin, simmondsinferulate, demethylsimmondsin (DMS), and didemethylsimmondsin (DDMS)). (Abbott *et al*., 2000)

Preparation of mango drink samples

Mangoes were passed to separate pulp from the stones and skin and the pulp obtained was ready to serve drinks (pulp 8%, acid 0.2% and sugar 16 Brix), and mixed with deferent concentration (1%, 2% and 3%) of jojoba extract (MS, MS^{-1}, LS and LS^{-1}). Mango drinks with chemical preservatives sodium benzoate (NaC6H5CO2)(0.1 %) was control sample (SB).The mango drinks samples were transferred to lock glass bottle (1 litter) and stored at room temperature (25ºC) for a period of 180 days.

Sensory evaluation of mango drinks

Individually sample of mango drink were presented to a board of judges for sensory assessment for color, taste, flavor, stickiness, and overall acceptability. The evaluation members was carried out by ten experienced panelists from Desert Research center. The judges were provided with prescribed questionnaires to record their observation. The information contained on the performa was 9 = Like extremely; 8 = Like very much; 7 = Like moderately; 6 = Like slightly; 5 = Neither like nor dislike; 4 = Dislike slightly; 3 = Dislike moderately; 2 = Dislike very much; 1 = Dislike extremely. The panelists expectorated the drinks and rinsed mouth using distilled water between samples the method described by Larmond (1977). Samples were carried out after 30 days for analyses. The experiment was repeated twice and the values are presented as means (SD±).

Microbiological assay

The determination of the total microbial contamination of the drink samples were performed after 30 days until six months by the method outlined in compendium of methods for the microbiological examination of foods (Anon., 1992). Nutrient agar, (The media used in the present investigation were obtained from Microbiological Resources Center (Cairo) Faculty of Agriculture, Ain Shams University) was used for periodical determination of total bacterial count (TBC) in the stored mango drink samples. Nutrient medium was suspended/litre of distilled water, mixed thoroughly, pH adjusted at 7.2(25ºC) (Jenway 3510-UK), heated with frequent agitation and boiled for 1 minute to completely dissolve the ingredients and autoclaved at 121°C for 15 minutes. One gram sample was taken from each treated drink sample using aseptic techniques, placed in labeled sterile dilution bottles and made into a volume of 100 ml by distilled water to achieve 10-1 suspension under sterile conditions. The contents were mixed thoroughly and aliquots were serially diluted and enumerated onto Nutrient agar. Plates were subsequently incubated (Memmert 100-Germany) for 48h at 37°C and TBC was calculated using colony counter. Samples were carried out after every 30 days for analyses. The experiment was repeated twice and reported data represent mean values (CFU/ml) of these measurements (Saeed *et al*., 2010).

Physio chemical analyses of the drink

The main physical-chemical characteristics of the juices have been established, thus: the relative density of the juices was picnometrically measured, the refraction index with ABBÉ refractometer, the sugar content with a Carlzeiss Jena portable refractometer, the pH through the potentiometric method using pH-meter equipped with a SenTix81 combined glass electrode. The glass electrode was calibrated using standard buffer solutions. The turbidity of the juices was measured with a TURB 355 IR/T turbidimeter (Corina *et al*., 2006).

Hemolysis assay

The hemolytic activity of aqueous jojoba meal extract and aqueous jojoba leaves extract were evaluated using human erythrocytes. Different extracts at the concentrations ranging from 0.05 to 10 mg ml-1, were incubated with washed erythrocytes(108 cells) in PBS (Dulbecco's phosphate-buffered saline) pH 7.4 (100 µl) for 1 h at 37 °C. After centrifugation (1000 g for 5 min), the absorbance at 450 nm of the supernatant was measured. A parallel erythrocytes incubation in the presence of Triton X 0.1% and PBS served as controls inducing 100% and 0% hemolysis, respectively. Extracts hemolytic activities were expressed as LC50 corresponding to the concentration inducing 50% hemolysis (Feten *et al*, 2014).

Statistical analysis: Data were statistically analyzed, using analysis of variance (Steel *et al*., 1997). Duncan's Multiple Range Test was applied to assess the difference between means. Significance was defined at $p \leq 0.05$. Values are means of two experiments (SD±).

RESULTS AND DISCUSSION

Determination of phenols, tannins and simmondsins in extracts

Most searches on jojoba have aimed on the removal or conversion of simmondsin as the principal toxic constituent. Other components may add to the toxicity of jojoba leaves and meal. Phenolic compounds may impart sting and bitterness (Ozawa *et al* 1987). The simmondsin content in aqueous extract of jojoba defatted meal (MS) was (41.6 mg/ml) and contained (24.9 mg/ml) phenols, whereas the water extract of jojoba leaves (LS) contained (3.9 mg/ml) simmondsin and (10.3 mg/ml) phenols as shown in Fig (1).

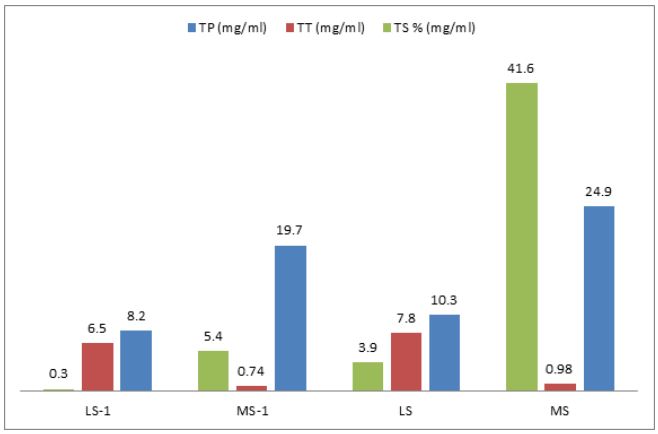


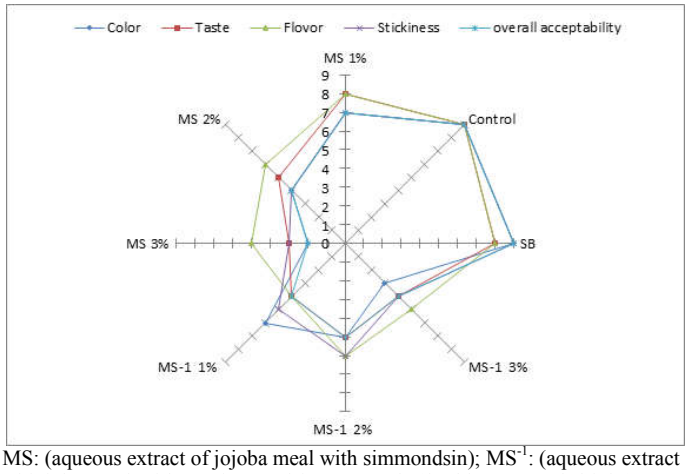
Fig.1. Total phenols, tannins and simmondsin (mg/ml) of jojoba aqueous extracts

TP: total phenols (eq-mg tannic acid/ml); TT: total tannins (eq mg tannic acid/ml) and TS: total simmondsin mg/ml eq sum of (Simmondsin, simmondsinferulate, demethylsimmondsin (DMS), and didemethylsimmondsin (DDMS)); MS: (aqueous extract of jojoba meal with simmondsin); MS^{-1}: (aqueous extract of jojoba meal without simmondsin); LS: (aqueous extract of jojoba leavesl with simmondsin); LS^{-1}: (aqueous extract of jojoba leaves without simmondsin).values are expressed as a mean ± SD; n=3. Acetone was found effective in removing 85% of thesimmondsins and 35% of phenols from jojoba meal and leaves (LUIS and AUGUSTO, 1990). The simmondsin was extracted at levels (5.4 mg/ml) in aqueous extract of jojoba defatted meal after treated with acetone (MS^{-1}), and phenols were extracted at levels (19.7 mg/ml). Whereas the aqueous extract of jojoba leaves after treated with acetone (LS^{-1}) contained (0.3 mg/ml) simmondsin and (8.2 mg/ml) phenols as shown in Fig (1).Tannins are the polyphenolic compounds the level of tannins in aqueous extract of jojoba defatted meal (MS) was (0.98 mg/ml) and (7.8 mg/ml) in aqueous extract of jojoba leaves (LS). Whereas the aqueous extract of jojoba defatted meal after treated with acetone (MS^{-1}) contained (0.74 mg/ml) and aqueous extract of jojoba leaves after treated with acetone (LS^{-1}) contained (5.6 mg/ml) tannins.

Sensory characteristics of mango drinks

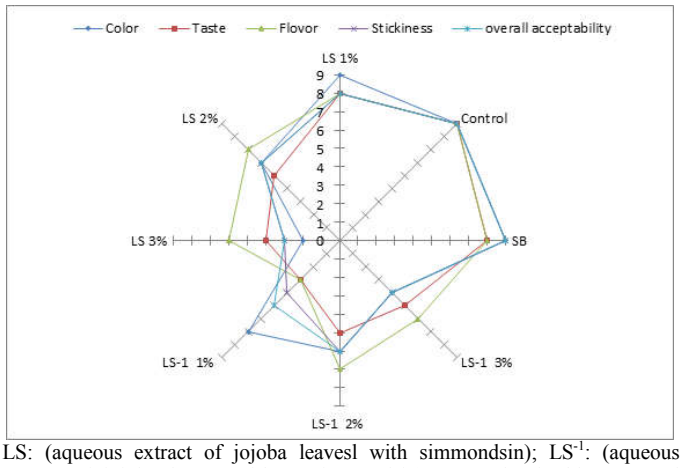
Mango juicesequipped from the treated flesh samples was voted focolour, flavour, taste, stickiness and overall acceptability. It is marked that addition of jojoba extracts preservatives greatlyimpacts these characteristics with a little loss in drink quality (Fig 2, 3 and 4). The gradesrefer to to the effect of the addition of jojoba aqueous extract of meal and leaves with simmondsins (MS and LS) and after removed simmondsins (MS^{-1} and LS^{-1}) as food preservatives to mango drink are givenin fig (2and 3). Concentration of MS 1% and LS 1%appear slight effect on their ability to act differently for weakening the taste, color, flavor, stickiness and overall acceptability of stored mango drink, the drink samples were

still liked very much by the panel of judgesfor color and flavor as shown in Fig (4).



MS: (aqueous extract of jojoba meal with simmondsin); MS^{-1}: (aqueous extract of jojoba meal without simmondsin); Control: (freshly prepared drinks); SB: sodium benzoate. values are expressed as a mean ± SD; n=3.

Fig.2. Effect on sensory characteristics mango drink with aqueous extracts of jojoba defatted meal



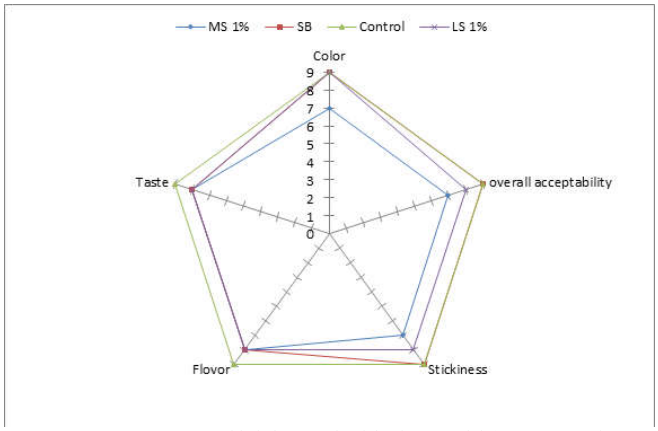
LS: (aqueous extract of jojoba leavesl with simmondsin); LS^{-1}: (aqueous extract of jojoba leaves without simmondsin); Control: (freshly prepared drinks); SB: sodium benzoate. values are expressed as a mean ± SD; n=3.

Fig.3. Effect on sensory characteristics of preserved mango drink treated with aqueous extracts of jojoba leaves

On the other hand, The extreme deterioration was detected with (MS3% and LS 3%) in the drink sample for all parameter and overall acceptability as a role of storage for the time, therefore must be rejected. Color score 2 for MS 3% and LS 3%, overall acceptability score for MS 3% and LS 3% respectively. The panelists noticeably known the changes in factor profile of the (LS 2% and LS^{-1} 2%) stored samples score inferior as compared to the freshly equipped drinks. Storage period always decrease flavor score until 30 days, nevertheless, the drink samples were still enjoyed by the judges for overall acceptability. A even form of failure in these sensory qualities of the drink samples treated with MS 2%, MS^{-1} 1% , MS^{-1} 2% , MS^{-1} 3% and LS 3% were evident in relation to storage time which makes the samples were rejected.

Microbiological assay

Table 1 shown inhibitory effects of jojoba aqueous extract (MS, MS^{-1}, LS andLS^{-1}) on the bacterial growing of the mango drink at different concentrations (1,2 and 3 %) used in the food production. The maximum inhibitory properties on bacterial growth in mango drink samples were applied by MS and LS at a concentration of 3% followed by concentration of 2% of MS and LS of each. Increasing of MS^{-1} and LS^{-1} concentration from 1 to 3% reduced the growth rate, and concentration 1% of MS and LS were presented similarly active as matched with 1 mg/kg of the SB (Fig. 5). The results of the current study also confirmed an inhibitory influence of MS, MS^{-1}, LS and LS^{-1} in mango drink kept for six months. The maximum degree of pollution in mango drink samples was detected in control after 180 days, while the least contamination was presented in the LS 3%. Periodical examination of the mango drink samples for the TBC indicated a progressive increase in the rate of growth varied with different treatment for 180 days, suggesting the jojoba extract to be relatively inhibitor in mango drink. The results of the current study confirmed that the extracts used as preservatives were able to completely inhibit the bacterial growth in all concentrations for 180 days storage.



MS 1%: (aqueous extract of jojoba meal with simmondsin) concentration 1%; LS 1%: (aqueous extract of jojoba leavesl with simmondsin) concentration 1%; Control: (freshly prepared drinks); SB: sodium benzoate. values are expressed as a mean ± SD; n=3.

Fig.4. Slightly effect on sensory characteristics of preserved mango drink treated with jojoba aqueous extracts

Table 1. Effect of different jojoba aqueous extracts as preservatives (CFU/ml) during six months storage of mango drink

Treatment	Storage time (days)						
	0 days	30 days	60 days	90 days	120 days	150 days	180 days
MS 1%	15^{c}	17^{b}	18^{c}	23^{d}	25^{c}	30^{c}	39^{e}
MS 2%	14^{c}	14^{a}	16^{b}	17^{b}	22^{b}	26^{b}	31^{b}
MS 3%	11^{a}	13^{a}	14^{a}	15^{a}	19^{a}	24^{a}	27^{a}
MS-1 1%	12^{a}	17^{b}	25^{e}	32^{f}	48^{f}	67^{h}	93^{k}
MS-1 2%	12^{a}	13^{a}	18^{c}	28^{e}	41^{e}	59^{f}	73^{h}
MS-1 3%	14^{c}	16^{b}	19^{c}	24^{d}	38^{d}	46^{e}	61^{g}
LS 1%	11^{a}	12^{a}	13^{a}	19^{c}	23^{b}	33^{d}	46^{f}
LS 2%	13^{b}	14^{a}	15^{b}	19^{c}	24^{c}	31^{c}	37^{d}
LS 3%	12^{a}	12^{a}	14^{a}	19^{c}	21^{b}	26^{b}	32^{b}
LS-1 1%	13^{b}	19^{c}	27^{f}	39^{g}	52^{f}	74^{i}	108^{l}
LS-1 2%	11^{a}	14^{a}	23^{d}	29^{e}	42^{e}	68^{h}	91^{j}
LS-1 3%	13^{b}	16^{b}	22^{d}	37^{g}	51^{g}	64^{g}	79^{i}
SB	12^{a}	12^{a}	13^{a}	14^{a}	19^{a}	27^{b}	35^{c}
Control	11^{a}	72^{d}	194^{g}	310^{h}	524^{h}	698^{j}	847^{m}

MS: (aqueous extract of jojoba meal with simmondsin); MS^{-1}: (aqueous extract of jojoba meal without simmondsin); LS: (aqueous extract of jojoba leavesl with simmondsin); LS^{-1}: (aqueous extract of jojoba leaves without simmondsin). Means (± SD) sharing similar superscripts in a column are statistically non-significant ($p<0.05$).

Physicochemical analyses of drink

Incorporation of jojoba extract preservatives exhibited a significant ($p<0.05$) effect on physicochemical profile of

Table 2. Effect of different jojoba aqueous extracts as preservatives on physicochemical profile of mango drink during six months storage

Treatment	Relative density at (20ºC)	Refraction index at (20ºC)	Sugar content (%)	Turbidity (NTU)	pH at (20 ºC)	Protein (%)	Fat (%)
MS 1%	1013*	18.8*	17.1	3216*	3.8***	0.61**	0.56*
MS 2%	987	19.1	17.8	2371	3.2	0.54	0.54
MS 3%	979	19.4	17.9	1628	3.3	0.42	0.53
MS-1 1%	973	18.7	17.3	3167	3.5*	0.58	0.58***
MS-1 2%	969	18.8*	17.5	2743	3.4*	0.51	0.56*
MS-1 3%	962	18.9*	17.5	2139	3.2	0.46	0.54
LS 1%	1024**	18.5***	16.4**	3594***	3.6**	0.62***	0.57**
LS 2%	998	18.9*	17.4	3118	3.4*	0.57	0.54
LS 3%	991	18.9*	17.6	2674	3.4*	0.52	0.54
LS-1 1%	991	18.4***	16.1***	3187	3.2	0.62***	0.58***
LS-1 2%	987	18.6**	16.8	2847	3.1	0.59*	0.57**
LS-1 3%	982	18.7**	16.5**	2536	3.1	0.53	0.57**
SB	1031***	18.6**	16.7*	3462**	3.6**	0.58	0.58***
Control (fresh drink) baselines	1047	18.3	15.8	3729	3.9	0.64	0.58

MS: (aqueous extract of jojoba meal with simmondsin); MS^{-1}: (aqueous extract of jojoba meal without simmondsin); LS: (aqueous extract of jojoba leavesl with simmondsin); LS^{-1}: (aqueous extract of jojoba leaves without simmondsin).*P<0.05, **P<0.01, ***P<0.001, Changes from baselines by different concentration.

mango drink (Table 2). Addition of MS, MS^{-1}, LS and LS^{-1} at all concentration did not show a non-significant effect on the fat content of the samples. Increasing of extracts concentration from 1 to 3% reduced the protein content in mango drink sample. The results shown that jojoba aqueous extracts improved the acidity of drink with a agreeing decrease in pH value of the samples. Storage period had displayed a pronounced effect on physicochemical preserved mango drink. Progressive reduction inturbidity, density and protein content of drink sample was detected over the entire storage 180 days. The great sugar matter of drink might be qualified to the transformation of starch into soluble sugars under the action of enzymes during ripening, however, the increase in TSS was apparent in the last period of 180 days storage.

Hemolysis assay

Reports production about aqueous jojoba extract toxicity, we have detected that the (LS, LS^{-1} and MS^{-1}) extracts don't showed hemolytic action against human erythrocytes at concentrations ranging from 1 to 20 ml/kg body weight except for MS extract (LC50 = 3.5 ml kg body weight)

DISCUSSION

Alongsidephenolics and tannins ensure antimicrobial action that is affected by causes such as the aglycone, position and chemical structure of sugar side chains (Maier 2008). Tannins are the phenolic compounds performance as antibacterial agent for many pathogenic bacteria such as *Staphylococcus aureus*, *Staphylococcus epidermis*, *Bacillus cereus*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, *Salmonella typhi*and *Escherichia coli* (Kamal *et al*, 2010). The antimicrobial properties of aqueous jojoba extracts can be due to the richness of its organs on polyphenolic compounds. Many studies have confirmed that good linear interactions exist between antibacterial activity and the high level of phenolic components, and give emphasis to the importance of some classes of polyphenol such as phenolic acids and tannins. Phenolic compounds in plant justification appliance against pathogenic microorganisms, insects, and herbivores. However, we have observed that aqueous jojoba extracts from defatted meal and leaves exhibiting the highest antibacterial activity in food preservation, as compared with the chemical preservatives sodium benzoate. These results can be described by the nature of the components implicated in the food preservation as antimicrobial activity. The present results indicate that the isolated glucosides; Total simmondsin (Simmondsin, simmondsinferulate, demethylsimmondsin (DMS), and didemethylsimmondsin (DDMS)) have remarkable antimicrobial activities against. Moreover, they have moderate antifungal activity against. This can be explained that the simmondsin may have a role in the food preservation. Furthermore, the crude aqueous extracts of jojoba defatted meal and leaves with simmondsin were more potent than other extracts of the meal and leaves after removed simmondsin. It is concluded from these results that the isolated glucosides might be considered as key compounds for developing safe alternative food protection agents according to the IC50 values.

Conclusion

This study confirmed the inhibitory special effects of crude aqueous extract of jojoba meal and leaves with simmondsin (MS and LS) and without simmonds in (MS^{-1} and LS^{-1}) on infectious development in the mango drink kept under room temperature. Recommended that MS and LS at applications of 1% for each had been equally effective at 100 ppm sodium benzoate (SB) used separately. Additional, these aqueous extracts as food preservatives had significantly affected the physio chemically profile of the drink samples with a noticeable increase in acidity and parallel with decrease in pH through storage for six months. The result of jojoba aqueous extracts as preservatives on physiochemical profile and antimicrobial properties of stored mango drink shown in this study founds a major impact that can help the development of a safer and viable storage of mango drink at industrial scale according to the IC50 values.

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