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Original article

Formulation and quality control of *Prunus domestica* syrup, prepared according to Iranian Traditional Medicine

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Abstract

Background and objectives: *Prunus domestica* (plum) has been considered as a useful remedy for several disorders in Iranian Traditional Medicine (ITM). It has cold and wet temperament and is used as syrup for hot temperament diseases such as hot headache and stomach disorders. In the present study, plum syrup has been formulated according to ITM manuscripts and quality control evaluations have been accomplished to present a suitable formulation. **Methods**: The fruits of *Prunus domestica* L. were macerated in water, then decocted. The mixture was filtered. The filtrate was concentrated to have a suitable viscosity. The extract was sweetened by adding sugar (1:2) and heated till sugar was completely dissolved. The final product was evaluated physicochemically and microbiologically according to standard protocols and total phenolics content of the syrup stability was determined. The syrup was assessed in accelerated condition (40 ºC) during 6 months. **Results:** The prepared formulation was a viscose and brown syrup with plum flavor and fragrance. No precipitation and cap locking were observed in the syrup. Dry residue, pH, density, viscosity and total phenolics of the syrup were found 43.1%, 3.49, 1.27 g/ml, 6.5 cP and 152.3 mg/100ml, respectively. No microbial growth was observed in the formulation. In the accelerated stability tests, no remarkable changes were seen in the product. Total phenolics content was decreased 2.2% during 6 months in 40 ºC. **Conclusion:** The formulated *Prunus domestica* syrup could be introduced for further mass production after completing the final required evaluations.

Keywords: Formulation, Iranian Traditional Medicine, *Prunus domestica*, quality control, syrup

Introduction

Iranian Traditional Medicine (ITM) with its glorious background and effective remedies has been the focus of many researches in Iran and worldwide. The treatments mentioned in Iranian old manuscripts have been examined in lots of experiments and clinical trials, among them medicinal herbs have always been considered as natural sources which could present solutions to nowadays concerns for diseases.

Prunus domestica L. (plum), a member of Rosaceae family, is called "Ijjās" in ITM [1,2]. Sweet plums are cold in the first of second and

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moist in the last of the third degree. They produce relaxation in the stomach and are highly expelling of yellow bile according to ITM. It was believed that if plums were cooked with sugar, they could act as a proper purgative without causing considerable side effects [3,4]. Plum has been prescribed for diseases with hot temperament especially headaches and imbalances of stomach [5,6]. Since it is still used as a traditional medicine remedy, it's necessary to prepare a proper formulation of the fruits for faci litating its use for patients. In the present study, a syrup has been formulated according to Avicenna "*Al-qanun fi al-tib*" [5] and quality control of the syrup has been carried out to present a qualified formulation for usage.

Experimental

Plant material

Fruits of *Prunus domestica* were collected from the village of "Kharv", in Neishaboor city, Razavi Khorasan province, Iran. They were authenticated by botanists at the Herbarium of Traditional Medicine and Materia Medica Research Center, Shahid Beheshti University of Medical Sciences, Teharn, Iran. A voucher specimen was kept for future reference (TMRC-3562).

Preparation and extraction

According to traditional physicians, the ordinary dose of plum has been 5-10 fruits per day, therefore the volume of consuming the syrup was designed as if 10 fruits could be equal to 30 mL of the syrup for daily usage. The fruits were washed and macerated with water (1:5) for 3 h. The plums were then heated till the pulp was separated from the seeds (approximately 2 h) [5]. The mixture was filtered and the filtrate was concentrated by heating gently till the volume was 10 fold reduced. The precipitates which were formed during the heating process were filtered.

Preparing the syrup

To prepare the syrup, required amount of sugar was added to the above extract (1:2) and the syrup was heated till sugar was completely dissolved. Methyl paraben (0.1%) and propyl paraben (0.015%) were added as microbial preservatives.

Quality control of the syrup

Macroscopic characteristics

Color, odor, taste and appearance of the syrup were examined.

Crystallization evaluation

The syrup was placed in a refrigerator for a week and was examined for any precipitates afterwards [7].

Cap locking

The syrup was placed in 60 mL bottles, and the bottles were turned upside down. The opening manner was evaluated after one week. Cap locking would be confirmed in case the cap could not be easily opened [7].

Dried residue

Five mL of the syrup was placed in an oven (110 °C). After 2 h, the sample was weighed following cooling in a desiccator. Heating was continued for 30 min afterwards and the measuring was repeated as mentioned above and finally dried residue was calculated [8].

pH

The pH of the syrup was measured with a Mettler Toledo 7 easy apparatus after calibration with buffers with pH 7 and 9.

Density

The density of the syrup was measured using a pycnometer 10 ml. Density was reported in g/mL.

Viscosity

Sixty mL of the syrup was placed in a Soofer viscometer Type Vt02 (Germany). Spindle No.1 was used and the viscosity was recorded.

Microbial evaluations

Total Viable Count (TVC)

TVC was measured according to the WHO protocols [8] by plate count method.

Test for specific microorganisms

Evaluating the presence of *Escherichia coli* and

Salmonella sp. in 10 mL of the syrup was carried out according to WHO protocols [8].

Total phenolics content

Total phenolics content was measured according to British Pharmacopeia [9]. Briefly, 1 mL of the syrup was adjusted to 100 mL with distilled water. 1mL of Folin-Ciocalteu reagent was added to 2 mL of the diluted syrup, then 10 mL distilled water was added to the mixture. The solution was diluted with sodium carbonate (29% w/v) up to 25 mL.

The absorbance was recorded after 30 min at 760 nm. Distilled water was used as the blank. Total phenolics content was calculated using pyrogallol calibration curve.

Accelerated stability tests

Sixty mL bottles of the syrup were placed in an oven (40 °C). Samples were evaluated according to the above mentioned measurements after 3 and 6 months [10].

Results and Discussion

The results of the quality control demonstrated that the syrup presented a brown viscose appearance with characteristic odor and taste of plum. No signs of crystallization/ precipitation or cap locking were observed. The results of the measurements along with the acceleration test have been shown in table 1.

Table 1. Results of accelerated stability evaluation of plum syrup

Measurement	Time (month)		
	0	**3**	**6**
Color	Brown	Brown	Brown
Odor	Plum	Plum	Plum
Taste	Sweat plum	Sweat plum	Sweat plum
Density	1.27	1.27	1.27
Viscosity	6.5	6.5	6.5
pH	3.49	3.48	3.49
Total phenolics content (mg/100 mL)	152.3±4.7	150.4±2.1	149.0±3.5
TVC for bacteria (CFU/g)	0	0	1.1×10^2
TVC for fungi (CFU/g)	0	0	0
***Escherichia coli* (CFU/g)**	0	0	0
***Salmonella* sp.(CFU/g)**	0	0	0

As it is obvious in table 1, no considerable alterations have been recorded about the measured parameters. Decrease in the phenolics content has been demonstrated in figure 1. After three and six months the decrease in the phenolics contents has been reported to be 1.3% and 2.2%, respectively. Considering the maximum allowed decrease (5%) [10], it could be concluded that the syrup maintained acceptable stability after the 6 month period. Besides, other parameters have not shown significant changes which support the stability of the formulation.

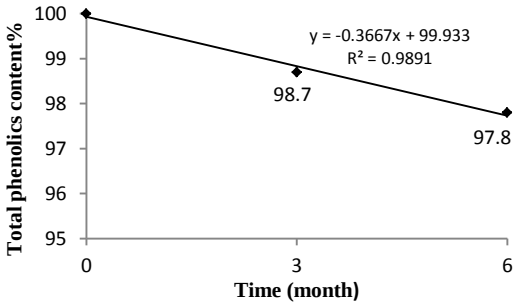

Figure 1. Percentage of Phenolic contents of plum syrup during six month at 40 °C

Prunus domestica fruits, known as plums or prunes, have been evaluated in several *in vitro, in vivo* as well as clinical studies.

Antibacterial, antifungal and antioxidant activities have been reported form *Prunus domestica* [11, 12]; also neochlorogenic acid and cryptochlorogenic acid which have been isolated from the fruits, have shown antioxidant activity [13]. Cytotoxic property and apoptotic induction of the ethanol fraction obtained from concentrated juice of the fruits has been recorded in Caco-2 cells [14]. Hepatopprotective activity has been observed in paracetamol and CCl_4 induced hepatitis in rat which had received *Prunus domestica* extracts. In this study, treatment with plum extract has been reported to bring back the biochemical markers such as liver enzymes near to the normal level [15].

Homoisoflavone glucosides (purunuside) from *Prunus domestica* have exhibited inhibitory activity against alpha-glucosidase enzyme in a previous study [16]; while some clinical data

could also be found about *Prunus domestica* fruits. Prunes have shown to be promising in a clinical trial for lowering blood pressure [17]; moreover, *Prunus domestica* dried fruits have been considered effective in preventing and reversing bone loss. The capability of the fruits in reversing bone loss in osteopenic postmenopausal women has been examined in a clinical study in comparison to dried apple and the fruits were found to increase bone mineral density of ulna and spine compared to dried apple. Dried plum fruits have also decreased serum levels of bone turnover markers relative to baseline values [18]. *Prunus domestica* fruits have been considered as a remedy in constipation in traditional and folk medicine of various parts of the world. This claimed indication has been evaluated and it was confirmed by the Panel on Dietetic Products, Nutrition and Allergies that daily consumption of about 100 g of dried plums can help the bowel in maintaining its normal function [19].

In Iran, plum syrup has been used in a variety of disorders in ITM. In the present study it has been formulated according to "*Al-qanun fi al-tib"* of Avicenna and it was further standardized based on its total phenolics content. Considering that the prepared syrup presented plum taste, it did not need any further flavorings.

Suitable viscosity is an important factor for liquid formulations. Higher viscosity often results in better stability since the amount of water, which is necessary for microorganisms growth, decreases and microbial growth would be confined. The microbial evaluations after 6 months demonstrated no growth of *E.coli* or *Salmonella* sp. and the results were acceptable regarding limits of TVC [8]. Beside the suitable viscosity of the product, this could be due the preparation process (heating) and also using preservatives in the formulation. Considering that preservatives efficacy decreases by time, again viscosity is considered as a major factor for microbial stability of the product. Decrease in total phenolics content of the syrup was acceptable during 6 month at 40 °C [10].

In conclusion, the plum syrup demonstrated agreeable physicochemical and microbial stability and it could be considered for further optimization processes for mass production of the formulation.

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Declaration of interest

The authors declare that there is no conflict of interest. The authors alone are responsible for the content of the paper.

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