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Challenges towards characterization and applications of a novel hydrocolloid: Persian gum

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ABSTRACT

Over the past few decades scientists have paid special attention to studying novel and natural polysaccharides due to the growing demand for ready meals, public awareness about the importance of natural fibers in the daily diet, as well as their wide range of applications especially in foods, pharmaceuticals and herbal medicines. Moreover, they are preferred to the biotechnologically produced ones as they are usually non-toxic, natural, biodegradable, biocompatible and ecologically friendly. Persian gum is one of these potential novel hydrocolloids which has been introduced and studied during the past few years. As well as outlining its botanical source, this review uses Persian gum as an example of the types of characterization that are necessary for such a new polysaccharide: physicochemical, structural, rheological, functional properties, interaction with other macromolecules (proteins and polysaccharides), as well as highlighting its key possible applications in foodstuffs.

1. Introduction

Almond trees and shrubs botanically belong to the *Rosaceae* family and *Prunus* genus. According to existing reports, they were originally found in the hot and dry climates of the Middle East, more likely the Iran plateau, and subsequently spread all over the world. Moreover, *Prunus* encompasses a large group of deciduous and evergreen trees and shrubs, including three subgenera (*Amygdalus*, *Prunophora* and *Cerasus*). The *amygdalus* subgenus also consists of various species of wild almonds (26 species) with different botanical characteristics and that usually possess a bitter taste [1,2].

Amygdalus scoparia Spach (Synonym: *Prunus scoparia* Spach), is one of the wild (mountain) almond species (Fig. 1) which can be found along with other wild species in alpine areas, foothills, lower altitudes and semi-arid areas of the Irano-Tourani Zones [2]. These species are appreciated mostly due to their roles in the economy (the usage of their by-products in perfume, pharmaceutical and chemical industries), as a natural resource, as well as in soil erosion control. They can generally tolerate dryness (drought), salinity, low soil fertility, wind, high and low temperatures. For those reasons, *Amygdalus scoparia* Spach is nowadays being widely used in breeding programs to generate rootstocks that are adaptable to climate changes as well as planting (seeds and seedlings) in mountains and deserts to control the desertification process which is rapidly happening in Iran [1].

These features make it very clear that *Amygdalus scoparia* Spach can be considered as a reliable and sustainable source for providing a natural exudate gum, Persian gum (PG), along other products (bitter almond, kernel oil, timber, and ornamentals). Iran, owing to its geographical and environmental situation, has traditionally been a great source for this product and at present, it annually exports over 400,000 kg of PG and it is predicted that this number will tremendously increase in a matter of a few years or so once the artificial population of seedlings is established [1,3••].

In recent years, the growing demand in food and pharmaceutical industries for safe, low price, easily accessible and sustainable, biodegradable, biocompatible, ecologically friendly and renewable natural sources for stabilizers and emulsifiers have attracted scientists to investigate the potential capabilities of existing natural gums and mucilages, as alternatives for the current ones which are getting more and more expensive (*e.g.*, gum tragacanth), unsustainable *e.g.* gum Arabic due to the periodical crisis in producing countries (*e.g.*, Senegal, Sudan and Somalia), or with health concerns (*e.g.*, bio based ones). To this end, Persian gum (PG) is a relatively unknown natural hydrocolloid but with abundant production and country-wide distribution, so that it has been recently considered as a potential alternative and its characteristics and applicability have recently been extensively studied. Hence, this review summarizes the types of investigation that have been performed on this gum and also highlights what else needs to be done to allow the wider application of this gum and others like it in the future.

2. Persian gum

As indicated above, it is clear that there are quite a number of *Prunus* species including: almond (*Prunus dulcis*), apricot (*Prunus armeniaca*),

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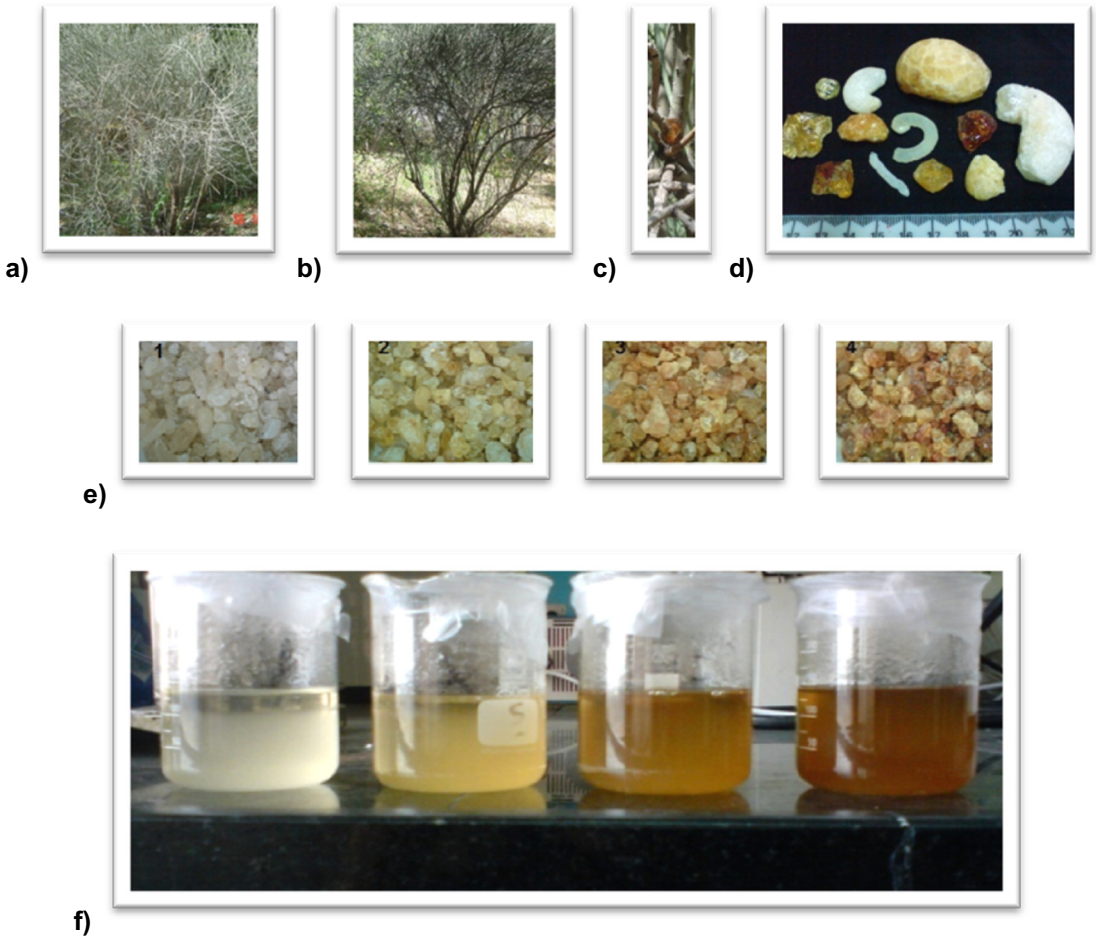

Fig. 1. Illustration of a) *Amygdalus scoparia* Spach shrub, b) Tree, c) PG tears on trunk, d) natural size, color, and shape of PG, e) PG lumps with different taints (light to dark from left to right), and f) their corresponding dispersions in water.

blackthorn (*Prunus spinosa*), cherry (various Prunus species), cherry laurel (*Prunus caroliniana* and *P. laurocerasus*), chokecherry (*Prunus virginiana*), plum (various *Prunus* species) nectarine and peach (*Prunus persica*): that have exudates that can potentially be used for several purposes, some locally and others at industrial levels [4]. However, the focus of this review is on *Amygdalus scoparia* Spach exudates or Persian gum (PG) due to its abundant production in comparison to the others.

PG is the natural exudate of mountain or wild almond (*Amygdalus scoparia* Spach) shrubs (Fig. 1a) or trees (Fig. 1b) which naturally grow in central Asia, Irano-Tourani and Zagrosi regions. The gum usually exudes from the trunks or branches (Fig. 1c) as a result of mechanical injuries, insect or microbial diseases, as well as climate adaptation (drought conditions) which is called physiological gummosis. It is also known as gum Zed, Zedu, Ozdu, Farsi or Shirazi, Angum or Angom, Arjhan, gomme notras, and gum gharacia [3••].

PG is commercially available in different colors (white, light yellow, dark yellow, light brown, dark brown, amber or red), shapes and sizes (Fig. 1d, e). It also disperses most easily in warm water and the color of the dispersion strongly depends on the color of PG powder (Fig. 1f). PG is classified as a partially soluble gum since it can be easily separated, particularly at low concentrations, by normal gravity with time (up to 5% w/w) or by centrifugal forces, into two distinct phase that contain soluble (25–30% w/w) and insoluble (70–75% w/w) material [3••,5••,6,7•,8,9••,10•,11••,12–14••]. Nevertheless, it has been recently reported that the soluble fraction itself consists of 35 and 65% w/w alcohol soluble and insoluble fractions, respectively [5••]. The former fraction possibly contains different mono, di, and oligosaccharides along with small molecule polysaccharides, while the latter includes various high molecular weight polysaccharides, since the higher the degree of polymerization (DP) lowers the solubility in alcohol. In contrast, it has been claimed [6] that only 7% w/w of PG can be truly considered as soluble when they conducted their study on PG which was dissolved in NaCl solution (0.2 M). Such a claim could not be true and might be misleading. It has been already confirmed [14••] that in the presence of NaCl (particularly over 0.02 M), PG is not dispersible and precipitates. This is likely why certain findings [6] on fractionation and molecular weight might be controversial. Based on this evidence, one may speculate that the existence of different structures (oligosaccharides and short chain polysaccharides) and their possible interactions under various conditions (pH, ionic strength, temperature) should be carefully considered prior to any functional characterization.

3. Physicochemical, structural and functional properties

The very first attempts (early 2006) on characterization of PG were started in the Food Colloids and Rheology laboratory of Tarbiat Modares University. Since then, quite a number of research studies have been conducted in many centers and universities in Iran and elsewhere. In the following sub-sections, the outcomes of the existing reports on the elemental composition, chemical structure, FTIR spectra, rheological properties, molecular weight, surface activity and emulsifying properties will be described in detail.