Food Hydrocolloids 25 (2011) 165–169

Contents lists available at ScienceDirect

Food Hydrocolloids

journal homepage: www.elsevier.com/locate/foodhyd

Review

# Biofunctional behaviour and health benefits of a specific gum arabic

Aled O. Phillips [a], Glyn O. Phillips [b,*]

[a] Institute of Nephrology, School of Medicine, University of Cardiff, Cardiff, Wales, UK
[b] Phillips Hydrocolloids Research Centre, Glyndŵr University, Wrexham, Wales, UK

ARTICLE INFO

*Article history:*
Received 2 March 2010
Accepted 18 March 2010

*Keywords:*
Dietary fibre
Gum
Arabic
Fermentation
Colon
Renal
Disease

ABSTRACT

Gum arabic (GA) is shown to conform to the definitions of dietary fibre, now finally adopted by the European Union and Codex Alimentarius. A non-starch polysaccharide, GA is not digested in the intestine but is fermented in the colon to give short-chain fatty acids, leading to a wide range of potential health benefits. An obstacle to regulatory approval of such health applications could be the wide natural variability of commercial gum arabic which has been demonstrated to change its molecular parameters and functional properties. For this reason, a well characterized and specific gum arabic (*Acacia (sen) SUPERGUM*™) has been produced, which has guaranteed structural reproducibility. We report here on the studies in vivo and in vitro with this material, which show its compatibility in the diet of patients suffering with diabetes mellitus and reduction in systolic blood pressure, which may translate into improved cardiovascular outcome and a reduction in the progression of renal disease.



**Contents**



## 1. Definitions of dietary fibre

Although Trowell proposed the term “dietary fibre” between 1972 and 1976 (Trowell, 1972; Trowel et al., 1976) it was only in 2008 that the first regulatory and legal international definition was approved in the EC. Directive 2008/100/EC states:

*For the purposes of this Directive “fibre” means carbohydrate with three of more monomeric units, which are neither digested nor absorbed in the human small intestine and belong to the following categories:*

- *edible carbohydrate polymers naturally occurring in the food as consumed;*
- *edible carbohydrate polymers which have been obtained from food raw material by physical, enzymic or chemical means and which have a beneficial physiological effect demonstrated by generally accepted scientific evidence;*
- *edible synthetic carbohydrate polymers which have beneficial physiological effect demonstrated by generally accepted scientific evidence.*

Codex Alimentarius debated over 10 years at least and only at the 32nd Commission in Rome in 2009 was this compromise definition agreed:

*Dietary fibre means carbohydrate polymers with ten or more monomeric units which are not hydrolysed by the endogenous enzymes in the small intestine of humans and belong to the following categories:*

- *edible carbohydrate polymers naturally occurring in the food as consumed,*

* Corresponding author.
*E-mail address:* phillipsglyn@aol.com (G.O. Phillips).

0268-005X/$ – see front matter © 2010 Published by Elsevier Ltd.
doi:10.1016/j.foodhyd.2010.03.012

- *carbohydrate polymers, which have been obtained from food raw material by physiological, enzymic or chemical means and which have been shown to have a physiological effect of benefit to health as demonstrated by generally accepted scientific evidence to competent authorities,*
- *synthetic carbohydrate polymers which have been shown to have a physiological effect of benefit to health as demonstrated by generally accepted scientific evidence to competent authorities.*

*Footnote 1: on lignin, etc. – this is pending adoption of Methods of Analysis and Sampling.*

*Footnote 2: Decision on whether to include carbohydrates with monomeric units from 3 to 9 should be left to national authorities.*

The scientific and regulatory complexities of recognizing gum arabic as a dietary fibre have been discussed (Phillips, Ogasawara, & Ushida, 2008). The main difficulty arose from the classification of gum arabic as a "food additive" and was authorized to be used in food on this basis (E414, INS 414). This approval only covered its use as an "emulsifier, stabilizer and thickening agent". The threat was that the Novel Foods Legislation introduced in May 1997 in Europe would need to be invoked before its use as a dietary fibre could be allowed. When we presented evidence to the UK Food Safety Agency that gum arabic had been used before this legislation, gum arabic was eventually accorded status as a food ingredient as well as a food additive, which was then accepted in other EC Member States. This view has a now been enshrined in an EC Catalogue in 2008, which now accords this new comprehensive status to gum arabic. The entry reads as follows:

*Common names*
*gum arabic, acacia gum*
*Status:*

"*This product was on the market as a food or food ingredient and consumed to a significant degree before 15 May 1997. Thus its access to the market is not subject to the Novel Food Regulation (EC) No. 258/97. However, other specific legislation may restrict the placing on the market of this product as a food or food ingredient in some Member States. Therefore, it is recommended to check with the national competent authorities.*"

Approval in the UK and France of gum arabic as a food dietary fibre is now well accepted and it is inconceivable now that after such protracted negotiation and legal support that this use would be queried anywhere in the world. It has been a long and hard road to achieve this end result. There are, of course, implied health benefits when using a product as a dietary fibre, either alone or in combination with other food ingredients. Such physiological effects of gum arabic and its beneficial influence on certain health conditions have been widely reported (Cherbut et al., 2003; Meance 2004; Phillips et al., 2008). These include trophic effects on gut mucous membrane, reduction of diarrhea, hypocholesterolemic and hypoglycaemic effects, with a beneficial influence also in renal disease. The EC is currently considering certain "health claims" for a wide variety of food ingredients, including gum arabic, and has yet to pronounce on their validity.

## 2. Characterisation and safety of test material

Fundamental to the use of a particular material in any specific health application is the guarantee that it is safe and that the health benefits claimed can be scientifically proven to the appropriate health authorities. This implies that the material must be reproducible in quality and chemical composition. With a natural material obtained from the exudates of Acacia trees of varying species and from different geographical regions, climates and soils, it is inevitable that the final product can be extremely variable, particularly after commercial spray drying and other processing. Conventional gum arabic is also subject to seasonal and geographical differences in the proportion of sugars in the gum (Glicksman, 1969), and to increase in the arabinogalactan protein component with aging of tree (Idris, Williams, & Phillips, 1998). This has been extensively demonstrated and also it has been shown that the structural variations which arise from natural and commercial processes also considerably modify their properties and functional behaviour. A study of 75 commercial gum arabic samples showed that their average molecular weight varied from 4.6 to 10.2 $\times$ $10^5$ (Al-Assaf et al., 2005a, 2005b).

It is advisable, if not necessary, that the biological and clinical studies should be undertaken with a test article which is specific and reproducible in its structure and properties. Here the evidence will be described for the studies undertaken on such a specific gum arabic, designated *Acacia (sen) SUPERGUM*™, full details of which have been described (Al-Assaf, Phillips, & Sasaki, 2007; Aoki, Katayama, Al-Assaf, & Phillips, 2007; Cui, Phillips, Blackwel, & Nikiforuk, 2007; Pickles et al., 2007). The gum arabic used for the studies reported in this paper have the physical and chemical properties shown in Table 1, which can be reproduced accurately.

Gum arabic is inherently a safe material for humans and has been accorded an ADI value "not specified", which means that, on the basis of the available data (toxicological, biochemical and other) the total daily intake of the substance arising from its use or uses at the levels necessary to achieve the desired effect in food does not represent a hazard to health. For this reason the establishment of an ADI in mg/kg body weight is not deemed necessary for gum arabic (WHO, 1982, 1990, 1995, 2000). *Acacia (sen) SUPERGUM*™ is a gum arabic of high and specific molecular weight which has improved functionality in emulsion systems (Aoki et al., 2007a). It is thus not subjected to the wide structural variations encountered in the raw natural product. It has exactly the same chemical components, which are present in the same amount, as conventional gum arabic in terms of the sugars, uronic acids and protein present. It is only the distribution of the protein which is different, with the maturation process of production aggregating the arabinogalactan and glycoprotein components to yield greater amounts of arabinogalactan protein. Nevertheless, although not different in chemical components from conventional gum arabic, a study of its toxicology was undertaken (Doi et al., 2006).

SUPER GUM™ is acceptable within all the food regulatory systems, and does not require any specific approval, since it is obtained with similar food processing methods as traditional gum arabic. In a 13-week feeding study of gum arabic (SUPER GUM™) in F344 rats, no treatment-related adverse effects were observed for any parameter in either sex of animals receiving up to a dietary level of 5.0%. Similarly, no adverse effects were noted in rats fed conventional gum arabic at dietary levels of 5% or more subchronically (Anderson, 1986; NTP TR No. 227, 1982). During our study, the treatment had no effects on clinical signs, survival, body

**Table 1**
Physical and chemical properties of Acacia (sen) SUPERGUM EM2.

| Acacia (sen) SUPERGUM | EM2 |
|---|---|
| Average $M_w$ | $2.54 \times 10^6$ |
| $M_w$ of AGP[a] | $1.16 \times 10^7$ |
| $M_w$ of AG[b] | $4.50 \times 10^5$ |
| $[\eta]$ dl/g[c] | 0.216 |
| $dn/dc$ ml/g | 0.141 |
| Protein (dry matter %) | 2.54 |

[a] Weight average molecular weight of the arabainogalactan protein component.
[b] Weight average molecular weight of the arabinogalactan component.
[c] Intrinsic viscosity.