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Properties of gum exudates from selected *Albizia* species from Tanzania

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Abstract

Gum samples from three selected *Albizia* species from Tanzania have been analysed and their commercial potential determined by comparing their properties with those of *Albizia zygia* and *Acacia* gums. The properties of the gum exudates from *Albizia amara, Albizia pertesiana* and *Albizia harveyi* have been found to be similar to those of *A. zygia* gum except that their aqueous solutions possess slightly lower viscosity and higher levels of tannin. The *Albizia* gums were much less soluble in water than *Acacia* gums; however, their methoxyl contents and acid equivalent weights (AEW) were similar to those of some *Acacia* gums. © 2002 Published by Elsevier Science Ltd.

Keywords: Properties; *Albizia*; Gum exudates; Leguminosae

1. Introduction

Albizia gum is derived from trees of the genus *Albizia* and is formed as round elongated tears of variable size and colour, ranging from yellow to dark brown (Mital & Adotey, 1971). The genus *Albizia* (family leguminosae, Sub-family Mimosoideae, tribe Ingeae) consists of at least *150* species (Allen & Allen, 1981), 72 of which occur widely in Africa. The family includes gum-producing genera of *Acacia* and *Prosopis*. The gum exudates from *A. zygia* (Ashton, Jefferies, Morley, Pass, Phillips, & Power, 1975) and *A. lebbeck* have been investigated extensively as possible substitutes for gum arabic. The trees are widespread in Ghana, Senegal, South Africa, India and Australia (Irvine, 1961).

After the first Sahelian drought (1973–1974) the gum exudates from *A. zygia* and *A. lebbeck* were investigated (Ashton et al., 1975; US National Academy of Sciences, 1979) in a pilot study aimed at finding non-A *cacia* sources of natural emulsifiers for food and pharmaceuticals. Comprehensive studies of the physicochemical properties of *A. zygia* gum, including its functionality in multiphase food systems have been reported by Mital and Adotey (1971, 1972, 1973). No complete structure of gums from *Albizia* species has so far been proposed, however a partial structure, consisting of a main chain of β-1→3 D-galactose units with some β-1→6 linked D-galactose units, has been proposed (Drummond & Percival, 1961). This paper reports the physicochemical properties of gum exudates from three *Albizia* species and assesses their commercial potential by comparing their properties with *A. zygia* gum and gums from some *Acacia* species.

2. Materials and methods

Acetyl content was determined by the method of Jefferies, Pass, and Phillips (1977a, 1977b). The detailed experimental procedures for all the other parameters have been described previously (Mhinzi & Mrosso, 1995).

3. Results and discussion

The physicochemical data for the samples studied are summarized in Tables 1–3. Gums are heterogeneous substances and can be separated into a soluble fraction and an insoluble fraction (insoluble gel + insoluble matter) which is partially soluble in hot water. The insoluble fractions is taken as a measure of the quality of the gum and has been found to vary widely among tree exudate gums. A good quality gum is almost soluble in water and possesses a very small proportion of insoluble fraction. The insoluble fraction of *A. amara* and *A. harveyi* gums are similar to those reported previously for *A.*

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zygia (20% w/w; Ashton et. al., 1975) whereas the insoluble fraction of the gum sample from *Albizia petersiana* is similar to those found in some *Acacia* spp., for example *A. senegal* var *leiorhachis* (8.9% w/w) and *A. tortilis* ssp *spirocarpa* (13.3% w/w) (Mhinzi & Mrosso, 1995). The insoluble gel of *Acacia* gums is known to have a higher molecular weight than the soluble fraction.

Albizia gums are known to exhibit pseudo plastic behaviour with thixotropy such that shear thinning behaviour is observed beyond 1.5% w/v. Work by Ashton et al. (1975) has shown that the gum exudate from *Albizia zygia* has a viscosity of 10 cPs at l% w/v. This is much higher than any of the *Albizia* samples studied, even though the insoluble gel fraction of *A. amara* (17.30% w/w) and *A. harveyi* (21.02% w/w) gums are similar to those obtained for the gum sample of *A. zygia* (20% w/w). This behaviour is different from that observed for gum ghatti (Jefferies et al., 1977a). It has previously been shown that commercial gum ghatti consists of a soluble fraction and an insoluble gel fraction which ranges from 8 to 23% and the viscosity of the whole gum depends on the proportion of the insoluble gel fraction.

Table 1
Some physicochemical properties of *Albizia* gums

Parameter	*Albizia amara*	*Albizia harveyi*	*Albizia petersiana*
Moisture (%w/w)	16.0	15.8	14.9
insoluble matter (%w/w)	1.20	0.22	1.68
CWIG (%w/w)	16.1	20.8	7.7
HWIG (%w/w)	14.0	17.6	7.4
Ash (%w/w)	*5.5*	4.9	*5.1*
Absorbance	0.10	0.12	0.16
Tannin (%w/w)	0.42	1.19	0.26
Methoxyl (%w/w)	0.62	0.58	0.37
Acetyl (%w/w)	3.13	2.73	2.91
[α]∼(degrees)	−11.0	−13.2	−27.2
Nitrogen (%w/w)	0.51	0.46	1.09
pH (15 g/l aq. soln.)	4.9	4.8	*4.5*
% Salt form	93.8	94.9	83.6
AEW	1152	610	1171

CWIG, cold water-insoluble gel: HWIG, hot water insoluble gel: AEW, acid equivalent weight.

In this work, the tannin content of the gum exudate from *A. harveyi* has been found to be significantly higher than that previously reported (Anderson & Morrison, 1990) for the same species. Such substantial differences in tannin content are not surprising because the amount of tannin in a given gum sample is a function of the time that it remains on a tree. Gum samples from some *Acacia* species from Tanzania, belonging to the series Vulgares, have also been shown to contain tannin. These are the gums from *A. polyacantha* ssp *campylacantha* (0.58%), *A. senegal* var *senegal* (0.28%) and *A. senegal* var *leiorhachis* (0.38% w/w) (Mhinzi & Mrosso, 1995).

All the *Albizia* gums analysed in this study are laevorotatory. Previous work by Anderson and Morrison (1990) gave values of −16 and −24° for the specific rotations of *A. amara* and *A. harveyi*, respectively. In this work, however, their respective values were −11.0 and −13.2°. Such a variation in magnitude may be ascribed to the variation between the exuding trees as has been reported previously by Duvallet et al. (1993), who obtained specific rotations which varied from −25 to −62° for 75 *A. senegal* gum samples.

The methoxyl content is derived mainly from 4-*O*-methyl glucuronic acid. Consistent with earlier studies, the methoxyl content of the gums analysed reveal a variation of this parameter among the species, making it a valuable chemotaxonomic marker.

The methoxyl content of the gum exudate from *A. amara* is comparable to that previously reported (0.5% w/w) by Anderson and Morrison (1990), whereas the value for *A. harveyi* is much higher than the reported value (0.1 %w/w). Similar differences in methoxyl content have previously been reported for *A. polycantha* ssp. *complycantha* by Mrosso (1996) (0.42%) and Anderson and Karamalla (1966) (0.2% w/w). The values of the methoxyl contents found in this work (Table 1) are comparable to those found in some *Acacia* species, for example *A. tortilis* ssp. *spirocarpa* (0.65%), *A. drepanolobium* (0.81%) and *A. kirkii* ssp. *kirkii* var. *kirkii* (0.47% w/w) (Mrosso, 1996).

Potentiometric titration furnishes the natural pH of the aqueous solution, percent salt form of anionic groups, acid equivalent weight (AEW) and the acetyl content. In agreement with previous reports (Anderson & Morrison, 1990; Ashton et. al., 1975), *Albizia* gums

Table 2
Viscosities of aqueous solutions of *Albizia* gums

Sample	Viscosity (cP)					
	0.1 (%w/v)	0.2 (%w/v)	0.4 (%w/v)	0.6 (%w/v)	0.8 (%w/v)	1.0 (%w/v)
Albizia amara	1.19	1.89	3.04	3.8	4.22	4.29
Albizia harveyi	1.38	1.97	3.01	3.69	4.69	5.04
Albizia petersiana	0.75	0.89	0.97	1.13	1.15	1.35

Table 3
Cationic composition of some *Albizia* gums

Element	*Albizia amara*	*Albizia harveyi*	*Albizia petersiana*
	(% w/w)		
Ca	1.30	1.09	0.542
Mg	0.407	0.528	0.353
K	1.40	0.891	1.23
Na	0.029	0.018	0.006
	(ppm)[a]		
Fe	59.4	28.5	82.7
Zn	37.9	12.7	39.4
Pb	21.0	6.3	5.2
Cu	5.43	6.15	14.5
Al	17.9	7.4	13.0
Mn	167	126	97.1
Cr	7.36	0.71	0.23
Co	2.4	2.2	1.79

[a] Values corrected for moisture and insoluble matter.

are slightly acidic, as indicated by their natural pH values. The percentage salt forms of the gums are similar to those recently reported for *Acacia* gums (Mhinzi & Mrosso, 1995; Mrosso, 1996). They are, however, higher than those of some other tree exudate gums, for example gum karaya (67.3%) (Jefferies et al., 1977b) or *Khaya grandifoliola* gum (54.3%) (Aslam, Pass, & Phillips, 1978). Previous work (Ashton et al., 1975) on *A. zygia*, shows that its AEW is comparable to that obtained in this work for the gum from *A. harveyi* but is lower than that from *A. amara* and *A. petersiana*. Examination of Table 1 reveals that the AEW of the gums from *A. amara* and *A. petersiana* are comparable to those obtained previously for some *Acacia* gums, for example, *Acacia seyal* var. *fistula* (1284) and *Acacia kirkii* ssp. *kirkii* var. *kirkii* (1110) (Mrosso, 1996).

The presence of the acetyl group may alter the viscosity of a gum sample, as has been observed when the acetyl group is removed or undergoes hydrolysis (Jefferies et al., 1977b). In this work the acetyl content was determined by the method developed by Jefferies et al. (1977b). The method produces results which are similar to other analytical methods, for example titration of the volatile acids. The *Albizia* gums analysed in this work have shown higher values of acetyl content than that reported for *A. zygia* gum (0.96%) (Phillips, Pass, Jefferies, & Morley, 1980). The values are also higher than some published values for *Acacia* gums, for example *Acacia sieberana* var. *villosa* (1.45%) and *Acacia polyacantha* ssp. *camplyacantha* (0.44%) (Jefferies et al., 1977b) but much lower than gums from the genus *Sterculia*, for example *Sterculia urens* (12.2%), *Sterculia setigera (16.5%)* and *Sterculia villosa* 14.78% (Anderson, McNab, & Anderson, 1982).

The nitrogen and amino acid contents are useful parameters in distinguishing gums from different species. In fact JECFA/FAO (1990) introduced a specification for the nitrogen content (0.26–0.39%) in the definition of gum arabic to ensure identity and purity of the gum. The immune responses, which are important in providing evidence for the safety of food additives, are customarily accredited to the proteinaceous component of the food component. It has also been established that film forming, emulsifying and stabilizing properties of a gum arise from the protein fraction (Randal, Phillips, & William, 1988).

The nitrogen contents *of A. harveyi* and *A. amara* gums, obtained in this work are the same as those reported previously (Anderson & Morisson, 1990) and are comparable to those obtained for some *Acacia* gums, for example *A. polyacantha* ssp. *camplyacantha* (0.44%) and *A. senegal* var. *leiorhachis* (0.42% w/w) (Mrosso, 1996). However, they are much higher than that of *A. lebbeck* which is thought to be related to *A. harveyi*.

The cationic compositions (except for sodium and potassium) were determined by atomic absorption spectrophotometry. The levels of potassium and sodium were determined by flame emission spectroscopy, employing an external calibration. The results show that *A. amara* and *A. petersiana* gums display a decreasing trend in metal ion composition, similar to that found by Anderson and Morisson (1990) in *Albizia* gums viz. K > Ca > Mg > Na. However, the amount of calcium is higher than potassium in *A. harveyi* gum and therefore assumes the trend observed in *Acacia* gums (Mrosso, 1996). The gum sample from *A. amara* shows an amount of lead which is in excess of the maximum permissible level of 10 ppm (British Pharmacopoeia, 1980; Food Chemicals Codex, 1981; JECFA/FAO, 1988) for gum arabic. It is also higher than that reported (5.32 ppm) by Anderson and Morisson (1990) for the same species. This is not surprising because metal ion composition is a function of the soil on which the plants grow and may therefore vary within samples obtained from the same species (Chikamai & Banks, 1993; Anderson & Wieping, 1992).

Comparison of metal ion contents of the *Albizia* gums studied in this work and Tanzanian commercial gum arabic (Mrosso, 1996), shows that the former has higher levels of potassium than the latter. In addition, the level of calcium in *A. amara* and *A. harveyi* is approximately twice that found in Tanzania commercial gum arabic (Mrosso, 1996; Mhinzi & Mosha, 1995).

The viscosity of gum ghatti (whole gum) has been previously reported (Jefferies et al., I977a) as increasing with increasing proportion of dispersible gel, a rheological behaviour also exhibited by *Albizia* exudate gums studied. Thus, both gum ghatti (Jefferies et al., 1977a) and *Albizia* gum solutions display higher viscosities and are expected to be better emulsifying and suspending agents than gum arabic. Overall, *Albizia petersiana,* in spite of its slightly lower viscosity and presence of tannin, best conforms to the various quality parameters reported for *A. zygia* (Mital & Adotey, 1971, 1972, 1973). Indeed, *A. petersiana* gum is much more soluble than *A. zygia* gum. It has been suggested by Mital and Adotey (1971) that *Albizia* gum exudates have physicochemical properties comparable to those of *Acacia*. The *Albizia* gums studied in this work, however, show higher than the gum arabic permissible levels of nitrogen, tannin and ash contents. The specific rotation of *A. amara* and *A. harveyi* are also outside the range (−34 to −26°) specified for gum arabic for food and pharmaceutical applications. In conclusion, a study of gum samples from more *Albizia* species to obtain additional data on the various species would be useful.

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References

Allen, O. N., & Allen, E. K. (1981). *The Leguminosae. A source book of characteristics and uses*. London: Macmillan.

Anderson, D. M. W., & Karamalla, K. A. (1966). Studies on uronic acid materials, Part XIII. The composition of *Acacia* gums exudates. *Journal of the Chemical Society (C)*, 762–764.

Anderson, D. M. W., McNab, C. G. A., & Anderson, C. G. (1982). Studies on uronic acid materials. Part 58: Gum exudates from the genus *Sterculia* (gum karaya). *The International Tree Crops Journal*, *2*, 147–154.

Anderson, D. M. W., & Morrison, N. A. (1990). Identification of Albizia gum exudates which are not permitted as food additives. *Food Additives and Contaminants*, *7*(2), 175–180.

Anderson, D. M. W., & Weiping, W. (1992). Gum arabic (*Acacia senegal*) from Uganda: Characteristic NMR spectra, amino acid composition and gum/soil cationic relationship. *The International Tree Crops Journal*, *7*, 167–179.

Ashton, W. A., Jefferies, M., Morley, R. G., Pass, G., Phillips, G. O., & Power, D. M. J. (1975). Physical properties and applications of aqueous solutions of *Albizia zygia* gum. *Journal of the Science of Food and Agriculture*, *26*, 697–704.

Aslam, M., Pass, G., & Phillips, G. O. (1978). Properties of Khaya grandifoliola gum. *Journal of the Science of Food and Agriculture*, *29*, 563–568.

British Pharmacopoeia. (1980). The Medicine Commission, Vol. I and II. London Stationery Office.

Chikamai, B. N., & Banks, W. B. (1993). Gum arabic from Acacia senegal (L)willd. in Kenya. *Food Hydrocolloids*, *7*(6), 521.

Drummond, D. M. W., & Percival, E. J. (1961). Structural studies of gum exudates of *Albizia zygia*. *Journal of the Chemical Society*, 3908–3917.

Duvallet, S., Fenyo, J. C., & Vandevelde, M. C. (1993). The characterization of gum arabic from an experimental field of Ferlo (North Senegal). *Food Hydrocolloids*, *7*(4), 319–326.

Food Chemicals Codex III. (1981). Acacia *(Gum arabic)*. Washington, DC: National Academy Press.

Irvine, F. R. (1961). *Woody plants of Ghana*. London: Oxford University Press.

JECFA/FAO (1988). *Specification for identity and purity of certain food additives*. Vol. 38, pp. 114–116.

JECFA/FAO (1990). *Specification for identity and purity of certain food additives*. Food and Nutrition Paper No. 49, Rome.

Jefferies, M., Pass, G., & Phillips, G. O. (1977a). Viscosity of aqueous solutions of gum ghatti. *Journal of the Science of Food and Agriculture*, *28*, 173–179.

Jefferies, M., Pass, G., & Phillips, G. O. (1977b). The potentiometric titration of gum karaya and some other tree exudate gums. *Journal of Applied Chemistry and Biotechnology*, *27*, 625–630.

Mhinzi, G. S., & Mrosso, H. D. J. (1995). Studies on Tanzanian *Acacia* gums. Part 3. Some properties of gum exudates from the series Vulgares and Gunimiferae. *Food Chemistry*, *54*(3), 261.

Mital, H. C., & Adotey, J. (1971). Studies of *Albizia zygia* gum; certain physicochemical properties. *Pharmaceutica Acta Helvetiae*, *46*, 637–642.

Mital, H. C., & Adotey, J. (1972). Studies of *Albizia zygia* gum; rheological properties of mucilages. *Pharmaceutica Acta Helvetiae*, *47*, 508–515.

Mital, H. C., & Adotey, J. (1973). Studies of *Albizia zygia* gum; stabilisation of emulsions. *Pharmaceutica Acta Helvetiae*, *48*, 412–419.

Mrosso, H. D., (1996), A Study of properties of some Tanzanian *Acacia* gums, MSc thesis, University of Dar es Salaam.

Phillips, G. O., Pass, G., Jefferies, M. & Morley, R. G. (1980). In H. Neukon, & W. Pilnik (Eds.), *Gelling and thickening agents in foods*. Switzerland: Foster Publishing.

Randal, R. C., Phillips, G. O., & William, P. A. (1988). The role of proteinaceous component on emuisfying properties of gum arabic. *Journal of Food Hydrocoloids*., *2*, 131–140.

US National Academy of Sciences. (1979). *Tropical legumes* (pp. 171–184, 202–203). Washington, DC: National Academy of sciences.