Use of Potentiometric Titrimetry in Gum Arabic Quality Assessment

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Introduction

Gum arabic, a type of arabinogalactan protein based hydrocolloid is a gummy exudate of *Acacia senegal L.* Willdenow and other related *Acacia* species of African origin. The principal end use is in the food and pharmaceutical industry (80%) [1,2] where its performance has remained virtually unmatched by any known synthetic substitute. The physico-chemical characteristics of *Acacia* gums may vary widely [3-5] depending on geographical location, age of plant etc.The Phamacopoeia [6] and Food Chemicals Codex [7] describe specifications for gum arabic for pharmaceutical and food use respectively. The botanical origin of Tanazanian commercial gum arabic has not been entirely clear, although it is thought to be of inferior quality compared to Sudanese gum arabic [8]. We have used potentiometric titrimetry to compare the proportions of the acid groups in the salt form and free acid form between Tanzanian *Acacia* gums and the main world commercial grades from Sudan and Nigeria.

Results and Discussion

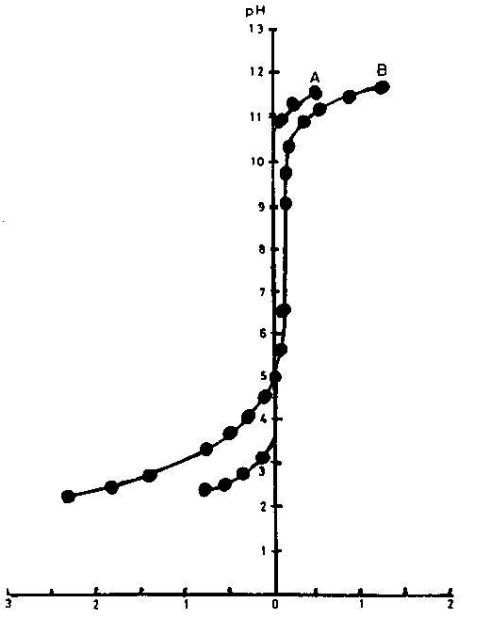
A typical potentiometric titration run, that of *A. drepanolobium* gum (3.0781 g in 200 cm^3 H_2O) is depicted in the figure. All titration curves obtained in this work conform to this monobasic description without exception. These curves have yielded the percent salt form and acid equivalent weight data shown in the table. The average % salt form of Tanzanian grade 1 commercial gum arabic (91.6) is identical with Sudanese "cleaned" grade (91.5) and closely resembles that of Nigerian grade 1 (90.4) but superior to "tahl" gum (85.8). The percentage salt form is linked to alkaline earth cationic content and diminished levels of Mg etc. are known to impart lower viscosities on gums [9,10]. The percent salt form and acid equivalent weight data for *A. drepanolobium* exudate matches with Tanzanian grade 1 gum arabic and this observation together with other previous pysico-chemical data [11,12] is confirmatory of the botanical origin of Tanzanian commercial gum arabic i.e. *A. drepanolobium*. Similar arguments give the identity of *A. seyal* var *seyal* as the source of Sudanese "tahl". For *A. seyal* var *seyal* exudate: % salt form 90.1, acid equivalent wt 1424.3 and for "tahl" % salt form 85.8; acid equivalent wt 1593.8. Our acid equivalent weight data shows remarkable agreement with published values for *A. seyal* (1470) and *A. polyacanthha* ssp *campylacantha*

Comparison of potentiometric titration data for Tanzania, World export grades (Sudanese and Nigerian) and various identified *Acacia* exudates.

	Natural pH	% Salt form[a]	Acid Equivalent weight
Sudanese "Cleaned" grade	4.80	91.5	1629.2
"Tahl" grade	4.65	85.8	1593.8
Nigerian grade 1	4.80	90.0	1603.7
Tanzanian grade 1	4.90	92.6	2028.4
	5.10	91.9	2291.4
	5.00	91.5	2343.9
	4.95	90.2	3032.8
A. drepanolobium	4.92	91.2	2262.8
A. seyal var *seyal*	4.85	90.1	1424.3
A. senegal var *leiorhachis*	4.75	89.1	1583.1
A. polyacantha ssp *campylacantha*	4.82	88.4	1935.0
A. tortilis ssp *spirocarpa*	4.72	80.7	2296.3

a = Results are corrected for moisture, insoluble matter and alkaline-earth metal content.
"Tahl" is an inferior export grade of Sudanese gum arabic.

The potentiometric titration of *acacia* gum (whole gum) (*A. drepanolobium* gum. 3.0781 g in 200 cm^3 water).



A = Deionised water

B = Gum solution

(1900) [4]. Commercial samples may show deviations if more than one *Acacia* source is harvested. Acid equivalent weights, if linked to overall molecular weight patterns are known to influence viscosity which increases with molecular weight [13]. In conjunction with other tests, the potentiometric titrimetry techniques has shown that Tanzanian commercial gum arabic is technically competitive with other world export grades from Sudan and Nigeria and quality deterioration cannot be substantiated. The factors precipitating the collapse of the gum trade are unknown, but the absence of a hand-grading practice and a pricing policy without incentives for quality encourage improper gum collection habits, including adulteration of shipments with gums from other tree species. Potentiometric titrimetry of the natural gum is a simple and direct method of determining acid equivalent weight, and is thus recommended to be included in routine quality assessment of batches of commercial gum arabic.

Experimental

Gum arabic samples

The Sudanese and Nigerian grades used as standards were supplied by exporters in the country of origin or the U.K. importers. Tanzanian commercial gum arabic samples were purchased from collectors and agents in the producing regions in central Tanzania (Dodoma, Singida and Shinyanga) and subsequently hand-graded (no hand-grading is done in Tanzania). Exudates of identified *Acacia* species were collected together with botanical vouchers for authentication at The Royal Botanical Gardens, Kew, London.

Sample preparation

Gum arabic samples were milled to pass a 2 mm sieve, spread out in trays and allowed to equilibrate with atmospheric moisture for seven days and then stored in air-tight containers.

Potentiometric titration of gum arabic solutions

Gum arabic (3 g) was transferred into a 3-neck flask containing CO_2-free deionised water (200 cm^3) and stirred (magnetic stirrer) for 2 hours. A flow of nitrogen was maintained through the flask to prevent re-absorption of atmospheric CO_2. The pH of the solution was monitored by a combination electrode through one neck of the flask while aliquots of 0.05M NaOH were added from a burette loosely fitting though a quickfit cone in the central neck (to permit free escape of nitrogen). The pH was recorded one minute after each addition and continued to above pH 11.5. Aliquots of 1 M HCl were added to lower pH to the natural pH of the gum sample and the procedure

continued to a final pH value of below 2.5 at which complete conversion of the polyanion to the free acid is assumed. The titre values obtained permit evaluation of percent free acid and salt forms, total anionic groups and the acid equivalent weight of the polyanion. A titration run with 200 cm^3 of CO_2-free deionised water was carried out as a blank.

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