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Thermal behavior of gum arabic in comparison with cashew gum

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Abstract

Thermal behavior of gum arabic and cashew gum, the exudate polysaccharides from *Acacia* and *Anacardium occidentale L.*, containing different gum/water concentrations: 100/0, 80/20, 60/40, 50/50, 40/60, 20/80 and 5/95% w/w, were studied by differential scanning calorimetry (DSC) and thermogravimetry (TG). DSC thermal profiles for gum arabic with low water content (0–40%) showed an endothermic event at about 90°C (Tonset) and with increasing water content (50–80%) multiple melting endotherms and associated enthalpies were observed. Similar behavior was found in the DSC curves of cashew gum with Tonset of about 97°C. TG curves show two decomposition stages, the major decomposition occurred at 252°C (Tonset) to arabic and cashew gums pure.

Keywords: Gum arabic; Cashew gum; Exudates

1. Introduction

Gum arabic is the oldest and best known of all the tree gum exudates. The gum is the exudate from certain *Acacia* (family leguminosae) trees which occur in semi-arid land across sub-Saharan Africa. Sudan is the world's largest producer with production reaching 40,000 tonnes in 1996, Nigeria is the second largest, followed by Chad, Mali and Senegal [1]. It consists mainly of high molecular mass polysaccharides and their calcium, magnesium and potassium salts, which on hydrolysis yield arabinose, galactose, rhamnose and glucuronic acid. This gum is widely used in the food industry, it is nontoxic, odorless and tasteless. It interacts with water and has a wide range of applications such as: emulsification, texture control and flavor encapsulation. Cashew gum is an exudate from *Anacardium occidentale L.*, the tree grows in many tropical and subtropical countries like Brazil, which has 450,000 ha of plants [2], followed by India, Mozambique, Kenya and others. The gum is a complex polysaccharide that after hydrolysis results in a higher galactose content and other constituents such as: arabinose, glucose, rhammose, mannose and glucuronic acid [3–4]. It also interacts with water and has emulsifier, adhesive and stabilizer properties, so that it may be suitable as a substitute for gum arabic. The interactions between water and polysaccharides are complex and can be studied by thermal analysis. This investigation focuses on some aspects of phase transitions and decomposition behavior of the gum arabic and cashew gum with water.

2. Experimental

2.1. Origin and purification of gums

Gum arabic kr grade was purchased from Aldrich Chemical, USA. Crude cashew gum was collected as

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natural exudate from *A. Occidentale* trees in Araruama, Rio de Janeiro, Brazil, in October 1997. Clear nodules free of bark were purified by trituration, filtration, alcohol precipitation and vacuum dry.

2.2. Thermal analysis

2.2.1. Differential scanning calorimetry (DSC)

The thermal behavior was observed by DSC on a TA Instruments, model 2910. Samples weighing 6–12 mg were mixed with distilled water in aluminium pans. They were sealed hermetically and the samples were cooled from 25° to −50°C and subsequently heated to 250°C at a rate of 10°C/mm, in nitrogen atmosphere.

2.2.2. Thermogravimetry (TG)

The experiments were carried out on a TA Instruments SDT 2960, at a heating rate of 10°C/min in nitrogen atmosphere, from 0 to 800°C.

3. Results and discussion

Phase transitions in foods are often a result of changes in composition or temperature during processing or storage. Knowledge of transition temperatures and of the thermodynamic quantities are important to understand the processes such as: dehydration, evaporation, freezing and conservation. These processes are governed by the transition of water into the gaseous or crystalline state; the water is the most important non-nutrient component, solvent and plasticizer of food solids. Changes that are observed at the transition temperatures can be used for the description of the effects on physical properties [5–6]. Fig. 1 shows a comparison of DSC thermal profiles for gum arabic and cashew gum of varying water content in the concentrations: 100/0, 80/20, 60/40, 50/50, 40/60, 20/80 and 5/95% w/w. The curves of gum arabic with low water content (0–40%) showed an endothermic event, crystallite melting during heating, at about 90°C (Tonset). However with increasing water content (50–80%) multiple melting endotherms were observed, which reflect the water and heat induced disorganization of crystallites [7]. Samples with high water content (95%) show single endotherms, which may be attributed to organization systems. The melting temperature, T_m, was displaced with increasing water content. Similar behavior was also exhibited by the DSC curves of cashew gum with Tonset of about 97°C, but the melting temperature was not displaced when water content was 95%. The transition temperatures and estimation of associated enthalpies of the gum arabic and cashew gum at different water concentrations are given in Tables 1 and 2.

Table 1
DSC characteristics, transition temperatures and enthalpies in the gum arabic (GA) and different proportions of water

GA/water (% w/w)		T_O(°C)[a]	T_{p1} (°C)[b]	T_{p2} (°C)[c]	ΔH (cal/g)[d]
100/0		90.0	126.0	210.0	96.5
80/20		102.8	123.5	191.6	65.1
60/40		89.6	109.9	142.0	125
50/50	1° peak	−6.2	−1.3	6.6	21.0
	2° peak	150.0	174.3	177.6	64.1
40/60		−10.9	−0.1	4.9	29.8
20/80	1° peak	−5.1	2.9	18.3	61.8
	2° peak	170.0	181.6	187.8	47.4
5/95	1° peak	−2.52	3.0	15.0	66.4
	2° peak	147.5	179.2	187.6	454

[a] T_O: onset temperature.
[b] T_{p1}: peak temperature.
[c] T_{p2}: end peak temperature (T_m).
[d] ΔH: enthalpy of transition.

Fig. 2 depicts TG curves for gum arabic and cashew gum at different proportions of water. Two decomposition stages can be seen for both. The first stage

Table 2
DSC characteristics, transition temperatures and enthalpies in the cashew gum (CG) and different proportions of water

CG/water (% w/w)		T_O(°C)[a]	T_{p1} (°C)[b]	T_{p2} (°C)[c]	ΔH (cal/g)[d]
100/0		97.2	162.9	231.6	43.8
80/20		89.0	133.7	224.3	63.4
60/40		172.1	189.7	207.7	121
50/50		−8.2	−1.0	3.0	12.6
40/60	1° peak	−7.6	−0.9	3.7	17.4
	2° peak	92.1	101.2	105.3	17.8
20/80	1° peak	−5.5	3.0	11.2	56.3
	2° peak	161.0	162.0	172.5	44.2
05/95	1° peak	−1.7	3.3	9.4	64.9
	2° peak	102.6	127.6	134.6	453

[a] T_O: onset temperature.
[b] T_{p1}: peak temperature.
[c] T_{p2}: end peak temperature (T_m).
[d] ΔH: enthalpy of transition.

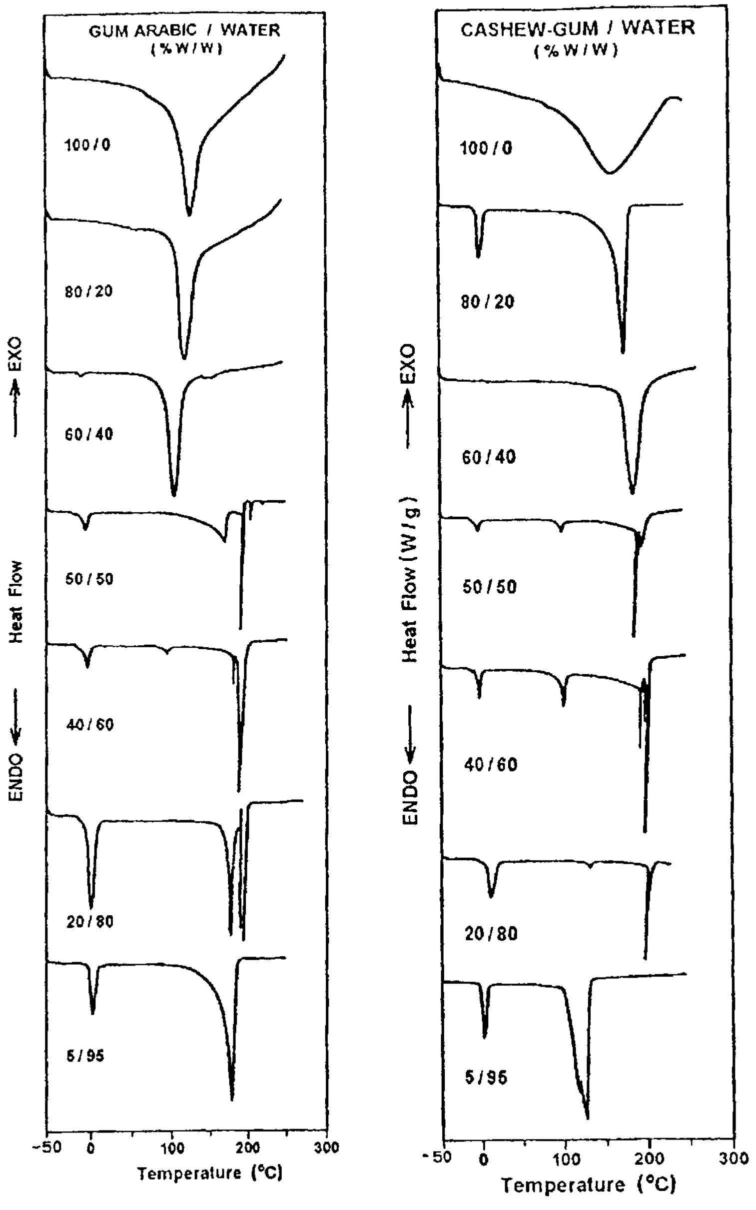

Fig. 1. Comparison of DSC thermograms of gum arabic and cashew gum when cooled and heated with various amounts of water.

occurred at around 100°C, relative the water loss and the second event occurred at 252°C (Tonset), this mass loss can be attributed to polysaccharides, with a composition of 73% and a residue of 15% in cashew gum and 65% of polysaccharides and a residue 20% for gum arabic in samples with low water content (0–20% w/w). The residue can be carbonacious.

4. Conclusions

From DSC thermal profiles data suggest gel formation and a solvation assisted melting of crystallites during heating of the gum arabic and cashew gum. The TG curves depict a similar thermal stability for both. In our opinion, in terms of thermal behavior the

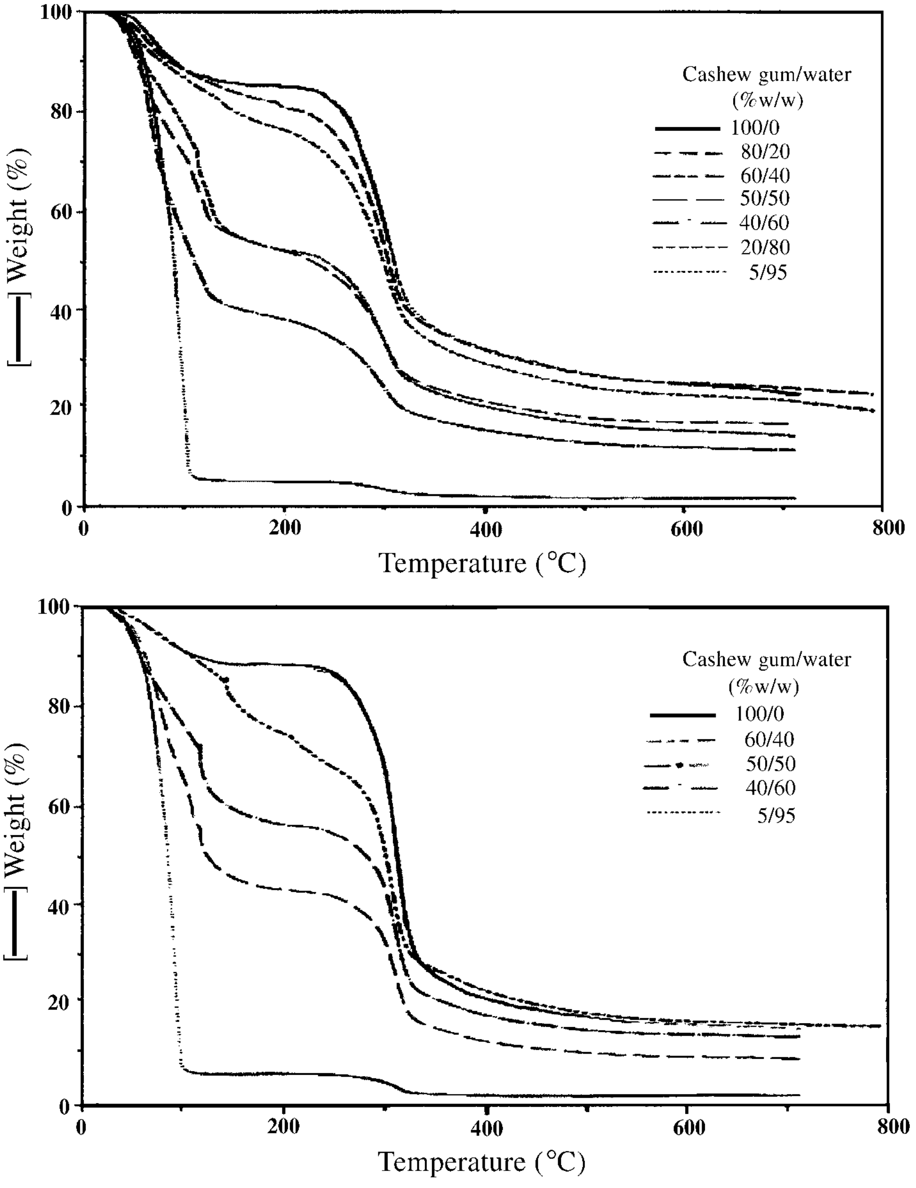

Fig. 2. Thermogravimetric curves for gum arabic and cashew gum with various amounts of water.

cashew gum may be suitable as a substitute for gum arabic.

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