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Some chemical properties of alum used in foods

(Beberapa sifat kimia tawas yang digunakan dalam makanan)

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Abstrak

Dua puluh contoh tawas yang digunakan dalam makanan telah diperoleh dan dianalisis secara kualitatif dan kuantitatif. Semua contoh tawas didapati mudah larut di dalam air dan asid hidroklorik (1%), sederhana larut di dalam natrium hidroksida (1%), dan tidak larut di dalam etanol (95%). Larutan tawas (5% b/i) bersifat asid (pH 3.0–3.2). Apabila dibandingkan dengan tawas potash yang tulen, semua contoh tawas tidak menunjukkan perbezaan yang ketara ($p > 0.05$) dalam kandungan aluminium, kalium dan sulfat serta kekurangan berat selepas dikeringkan. Keputusan ini menunjukkan bahawa semua contoh tawas ialah aluminium kalium sulfat dodekahidrat atau tawas potash dan mempunyai ketulenan sekurang-kurangnya 97%.

Abstract

Twenty samples of alum used in food were collected and analysed qualitatively and quantitatively. All the alum samples were readily soluble in both water and 1% hydrochloric acid, sparingly soluble in 1% sodium hydroxide and insoluble in 95% ethanol. The aqueous solution (5%) of alum was acidic (pH 3.0–3.2). All the alum samples, when compared with pure potash alum, showed no significant difference ($p > 0.05$) in the contents of aluminium, potassium and sulphate, and weight loss on drying. Results showed that all the alum samples were aluminium potassium sulphate dodecahydrate or potash alum, and that their purity was at least 97%.

Introduction

Alum is the common name given to the double sulphate salt of aluminium and ammonium or potassium or sodium. Alum is popular in rural regions as a water clarifying agent. In water, aluminium compounds form an insoluble hydroxide floc that readily absorbs sediments of cloudy water and precipitates from the solution.

Aluminium compounds are used in food as buffering, neutralizing or firming agents. The acidic salts are commonly used as leavening acids while the alkaline salts are used in cheese manufacture. Certain aluminium compounds are used in the preparation of self-raising flours, prepared food mixes and frozen bread doughs (Anon. 1972a; Ellinger 1972). Aluminium

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ammonium sulphate, aluminium potassium sulphate and aluminium sodium sulphate are listed as multiple-purpose GRAS (generally regarded as safe) food substances under the U.S. Code of Federal Regulations (Anon. 1985a). In Malaysia at the time of writing, these three aluminium compounds are not permitted for food use.

The type of alum available locally is called *tawas*. It is easily available in the sundry shops, especially the traditional Chinese medicine shops. It is colourless, odourless with a sweetish, astringent taste and is available in large, hard transparent cystals. Locally available alum is a popular firming agent for the pickling of fruits (Yeoh et al. 1990) and vegetables. It is also a popular leavening acid for making Chinese *you-tiao* (deep-fried twisted dough sticks). The amount of alum used in *you-tiao* may be as high as 2–3% of the formulation, based on 100% flour (He et al. 1987).

According to a comprehensive survey of the U.S. food industry (Anon. 1972b), aluminium ammonium sulphate is used in meat products, condiments, relishes and salt substitutes; aluminium potassium sulphate in reconstituted vegetable proteins, dairy product analogues, condiments, relishes and salt substitutes; whereas aluminium sodium sulphate is used in baked goods, baking mixes and reconstituted vegetable proteins.

The aim of this study is to determine the chemical identity of the locally available alum used in food, so that a better understanding of its uses and function in food can be obtained.

Materials and methods

Samples of alum (20) used for food were collected randomly from the shops in the northern, eastern, central and southern states of Peninsular Malaysia. The samples were ground into powder using an *IKA* micromill and stored in air-tight containers until analysis.

Qualitative detection of cations and anions (K, Na, NH_4, Al, SO_4) were carried out according to the standard procedures described by Svehla (1979).

The solubility of the samples in water, 1% sodium hydroxide, 1% hydrochloric acid and 95% ethanol were determined by dissolving known weights at room temperature.

The pH of 5% (w/v) aqueous solutions of alum were determined with an *Orion* Research pH meter (Model 501). Standard buffer solutions of pH 7.0 and 4.0 were used for calibration.

The weight loss on drying was determined by drying the sample at 240 °C for 6 h in a muffle furnance.

Aluminium was determined by direct precipitation as the aluminium 8-hydroxyquinolate, using 8-hydroxyquinoline and ammonium acetate (Furman 1975). The determination of potassium was done using a *Varian Techtron* atomic absorption spectrophotometer Model 175 at wavelength 769.9 nm. Potassium chloride was used as the standard (Williams 1979). Sulphate was determined by using a gravimetric method based on the insolubility of barium sulphate (Williams 1979).

The assay for potash alum [aluminium potassium sulphate dodecahydrate, $AlK(SO_4)_2.12H_20$] was carried out by mixing a solution of the sample with 0.05 M disodium EDTA, followed by titration with 0.05 M zinc sulphate (Anon. 1978).

The experiment was a completely random design with unequal replications (Steel and Torrie 1980). The test used to compare the means was a t-test with unequal numbers of observations and pooled variance, with the formula given as:

$$t = (\bar{X}_1 - \bar{X}_2) \div \sqrt{[(s^2 + 20) + (s^2 + 4)]}$$

where s^2 is the pooled variance, and $\bar{X}_1$ and $\bar{X}_2$ are the sample means of alum samples used for food and that of pure laboratory potash alum.

Results and discussion

Aluminium, potassium and sulphate ions

were detected in all the alum samples, whereas both sodium and ammonium ions were not detected. The alum samples collected from different shops were therefore of the similar type. The samples were found to be readily soluble (10 g/100 mL) in both water and 1% hydrochloric acid, sparingly soluble (2 g/100 mL) in 1% sodium hydroxide, and insoluble in 95% ethanol. The pH of 5% (w/v) aqueous solutions of alum ranged from 3.0 to 3.2. These characteristics of alum samples are similar to that of aluminium potassium sulphate (Anon. 1978).

There was no significant difference ($p > 0.05$) in the content of aluminium, potassium, sulphate, and weight loss on drying of alum samples when compared with those of pure potash alum (*Table 1* and *Table 2*). The alum samples were of high quality, with a purity of at least 97% potash alum (*Table 2*). Theoretically, by calculation using the atomic weights, pure aluminium potassium sulphate dodecahydrate has a molecular weight of 474.38, and contains 5.68% aluminium, 8.24% potassium, 40.47% sulphate and 45.53% water. It can be concluded that the locally available alum samples used in food are aluminium potassium sulphate dodecahydrate, commonly called potash alum.

Studies on humans have shown that aluminium when absorbed is readily excreted by the normal kidney. However, persons with kidney disease may be at risk if they consume excessive amounts of aluminium salts, as an elevated serum aluminium level can be toxic owing to the interference in phosphorus metabolism (Anon. 1975). Even though alum is used

Table 1. Aluminium, potassium and sulphate contents of alum used in foods and that of pure potash alum

Sample	Content (%)		
	Aluminium	Potassium	Sulphate
Alum (n = 20)	5.66a ± 0.01	7.80b ± 0.02	40.33c ± 0.12
Potash alum (n = 4)	5.64a ± 0.01	7.83 b ± 0.04	40.32c ± 0.17
t-value	1.24	0.80	0.07
df	22	22	22

n = number of samples
Values in each column with the same letters are not significantly different ($p > 0.05$)

Table 2. Loss of weight on drying and the purity assay of alum used in foods and that of potash alum

Sample	Weight loss (%)	Potash alum (%)
Alum (n = 20)	44.68a ± 0.06	97.87 ± 0.04
Potash alum (n = 4)	44.50a ± 0.12	–
t-value	1.39	
df	22	

Values in each column with the same letters are not significantly different ($p > 0.05$)

widely as an ingredient in various food products, at the time of writing it has not been listed as a permitted food conditioner in the Malaysian Food Regulations 1985 (Anon. 1985b) or Food(Amendment) Regulations 1988 (Anon. 1988). However, the Ministry of Health is currently in the process of reviewing the status of potash alum for food use.

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