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Compositional Changes of Jak Seed (*Artocarpus heterophyllus*) During Storage in Sand

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ABSTRACT. The nutritional potential of seeds from two varieties of jak, namely waraka and wela and their compositional changes during storage in sand (wali kos ata) were investigated.

A dry sand with a moisture content of less than 2.5% was found best for storage of jak seeds. The crude protein contents of seeds of wela (12.8%) were significantly higher than the waraka variety (10.8%). Duration of storage had significant effects ($P<0.05$) on the moisture, crude protein, ether extract, starch and total sugar contents of the seeds. In both varieties, crude protein and starch contents significantly decreased, while the sugar contents increased during storage. The jak seed stored in sand for 3 months contain 42–50 % more total sugar than the fresh seeds. The seeds of wela had a greater amylase inhibitor activity than waraka, but in both cases, the inhibitory activity declined with storage. Trypsin inhibitor activity was not detected in Jak seeds.

INTRODUCTION

Jak (*Artocarpus heterophyllus*) seed is a good source of carbohydrates and can play a useful role as a substitute for cereals. In Sri Lanka, jak seeds are cooked and used in many culinary preparations.

Jak seeds are often available as seasonal surpluses during certain months of the year, but the seeds do not keep well under normal storage conditions and go waste. In the rural areas of Sri Lanka, it is a traditional practice to store surplus jak seeds in sand (*wali kos ata*) and use them when necessary. Jak seeds can be stored in sand for long periods without any deterioration. It is the most economic and simplest type of storage. Seeds stored in such a manner are little sweeter and harder than the fresh seeds. Despite the widespread use of jak seeds as a human food, published information on its nutrient

composition is scanty. The objective of the present investigation was to study the nutrient composition of jak seeds and their compositional changes during storage in sand. Feeding a meal prepared from raw jak seeds is reported to cause deaths in chicks (Velauther and Ravindran, 1987). For this reason, the seeds were also analyzed for the presence of some anti-nutritional factors.

MATERIALS AND METHODS

Materials

Seeds of two local varieties, namely *waraka* (firm pulp) and *wela* (soft pulp), were obtained from the fully ripe fruits.

Storage

Clean sand was obtained and dried well. The sand and about 50 seeds were put in one-litre air-tight plastic containers and stored for 3 different storage periods, namely 1, 2 and 3 months. Each treatment was replicated thrice.

When villagers were interviewed to obtain information on storage practices of jak seeds in sand, contradictory views were presented regarding the moisture content of the sand. Approximately 30% deterioration of seeds was reported under normal conditions and we suspected that this may be related to the moisture content of the sand. To test this hypothesis, the seeds were also stored, in triplicates, under 4 moisture contents of sand, namely 2.5, 5, 7.5 and 10%.

Sample preparation

Fresh seeds and the seeds subjected to different periods of storage were dried to a constant weight at 60 C and the cotyledons ground in a wiley laboratory mill to pass through a 60-mesh sieve. The ground material was stored in airtight containers for subsequent analysis.

Nutrient analysis

Moisture, crude protein (N x 6.25), ether extract and ash contents were determined according to standard procedures. (AOAC, 1975). Defatted samples in triplicates, were extracted for soluble sugars as described by Garcia and Palmer (1980). The total soluble sugar content of the extract was determined by phenol – sulphuric acid method (Dubois *et. al.*, 1956). The reducing sugar content of the extract was determined by calorimetric method (Hodge and Hofreites, 1962). Non – starch polysaccharides (NSP) were determined as follows: Defatted samples were extracted for NSP by the procedure of Selvendran *et. al.*, (1980). This method involved removal of intracellular compounds with sodium deoxycholate, soluble sugars with 85% ethanol, protein with phenol: acetic acid water and starch with dimethyl sulphoxide. The resulting insoluble residue was dried and gravimetrically determined as NSP. Starch was assayed by the chemical method (Pucher *et. al.*, 1948).

Determination of Anti – nutritional Factors

Amylase inhibitor

Aliquots of seed extracts were pre – incubated with amylase solution in the presence of 30 µmol of phosphate buffer (pH 6.9) and 10.5 µmol NaCl in a total volume of 1.5 ml for 10 min at 37 C. Controls without the inhibitor were run simultaneously. The enzyme reaction was determined as described by Caraway (1959).

Trypsin inhibitor

The flour was extracted with 10 ml of extraction medium (containing sodium chloride) for 5 hours with gentle shaking. At the end of the 5 hr extraction period, the mixture was centrifuged at 15,000 g for 20 min. Aliquots of the combined supernatants were used for trypsin inhibitor assay. The trypsin inhibitor was determined by the procedure of Kakade *et. al.*, (1969).

Colour changes of endosperm

Colour changes in the endosperm during storage were recorded by the use of Munsell's colour chart.

RESULTS AND DISCUSSION

The results of the preliminary study of the effects of moisture level in sand on the storage quality of jak seeds showed that the seeds do not store well at moisture levels of above 2.5%. The results demonstrate that for optimum storage, a dry sand must be used. At moisture levels above 2.5%, the seeds germinated within one month storage in sand.

The changes in moisture, crude protein, ether extract and ash contents of seeds during storage in sand are presented in Table 1. The average crude protein contents of *waraka* and *wela* varieties were 10.8 and 12.8% respectively. These values are much higher than those reported for cereals (FAO, 1972) and highlight potential usefulness of jak seeds as a human food.

Table 1. **Changes in moisture, crude protein, ether extract and ash contents of jak seeds during storage in sand.**

Variety	Storage Period (months)	Moisture[a, b] (%)	Dry matter basis		
			Crude protein[a, b]	Ether extract[a, b]	Ash[a, b]
Waraka	0	63.7 ± 0.15[c]	10.8 ± 0.3	6.6 ± 0.2	2.2 ± 0.6
Wela	0	64.2 ± 0.2	12.8 ± 0.2	4.4 ± 0.2	2.6 ± 0.1
Waraka	1	63.3 ± 0.3	11.0 ± 0.8	1.9 ± 0.4	2.5 ± 0.2
Wela	1	62.9 ± 0.1	12.4 ± 0.1	4.1 ± 0.1	2.6 ± 0.2
Waraka	2	60.1 ± 0.4	10.6 ± 0.1	5.6 ± 0.1	2.4 ± 0.1
Wela	2	60.0 ± 0.4	11.4 ± 0.1	4.3 ± 0.3	4.6 ± 0.0
Waraka	3	56.9 ± 0.4	9.9 ± 0.1	5.6 ± 0.2	2.3 ± 0.2
Wela	3	54.6 ± 0.4	10.9 ± 0.1	4.0 ± 0.1	2.5 ± 0.1

a Varietal effects are significant ($P < 0.05$)
b Storage effects are significant ($P < 0.05$)
c Mean ± SE

Significant differences were observed among the two varieties in terms of these parameters. Seeds from *wela* variety contained significantly higher crude protein and ash contents, but ether extract contents were lower. These values were within the ranges reported for jak seeds in the literature (Sanjeevkumar *et. al.*, 1988; Velauther and Ravindran, 1987). Duration of storage had significant effects ($P<0.05$) on the moisture, crude protein and ether extract contents of the seeds. In both varieties, these parameters declined with the increasing storage time, particularly after two months of storage. Of these, only the decrease in crude protein content is of any nutritional significance. The crude protein content of seeds stored for three months was 8 – 15 % lower than that of fresh seeds.

The total sugar content of seeds from *waraka* variety was significantly higher than that of *wela*, whereas the non – starch polysaccharides were significantly higher in *wela* seeds (Table 2). No

Table 2. Changes in starch, total sugar, reducing sugar, non reducing sugar, non – starch polysaccharides of jak seeds during storage in sand.

Variety	Storage Period (months)	% Dry matter basis				
		Starch[b]	Total Sugar[a, b]	Reducing Sugar[b]	Non reducing Sugar[b]	Non starch polysaccharides[a]
Waraka	0	32.8 ± 1.4 [c]	12.8 ± 0.5	4.6 ± 0.1	8.3 ± 0.5	8.0 ± 0.5
Wela	0	34.0 ± 0.3	11.9 ± 0.1	3.9 ± 0.1	8.0 ± 0.1	29.1 ± 0.2
Waraka	1	32.2 ± 0.3	12.7 ± 0.1	4.4 ± 0.4	8.0 ± 0.1	27.7 ± 0.1
Wela	1	32.9 ± 0.7	12.7 ± 0.4	4.0 ± 0.2	8.3 ± 0.2	28.7 ± 0.4
Waraka	2	29.4 ± 0.4	14.6 ± 0.2	6.1 ± 0.1	8.6 ± 0.3	27.8 ± 0.6
Wela	2	30.1 ± 0.4	14.2 ± 0.2	5.9 ± 0.2	8.6 ± 0.1	29.0 ± 0.1
Waraka	3	27.8 ± 0.6	17.8 ± 0.1	7.4 ± 0.1	10.4 ± 0.1	28.0 ± 0.2
Wela	3	28.0 ± 0.1	17.8 ± 0.1	7.8 ± 0.1	10.0 ± 0.1	29.0 ± 0.6

a Varietal effects are significant ($P<0.05$)
b Storage effects are significant ($P<0.05$)
c Mean ± SE

significant differences were seen among the two varieties in terms of starch, reducing sugar and non-reducing sugar contents. Starch contents of jak seeds significantly decrease during storage, while the sugar contents increased. Jak seeds stored in sand for 3 months contained 42-50 % more sugar than the fresh seeds. These results lend support to the popular belief that jak seeds become sweeter during storage.

Storage in sand had significant effects on pH and titrable acidity of jak seeds (Table 3). The pH decreased and the titrable acidity increased with increasing storage time. Significant varietal and storage effects were also seen with regard to amylase inhibitor acidity of jak seeds (Table 3). The seeds from *wela* variety had a greater inhibitor activity. In both varieties, the inhibitor activity declined with storage. However the amylase inhibitor activity in jak seeds should not be of any nutritional concern, since these are known to be destroyed during cooking (De Mulelenaere, 1964). The analysis revealed that there is no trypsin inhibitor activity in jak seeds.

Table 3. **Changes in pH, titrable acidity and amylase inhibitor of jak seeds during storage in sand.**

Variety	Storage period	pH [b]	Titrable acidity [b]	Amylase inhibitor [a, b] lu/g	Trypsin inhibitor lu/g
Waraka	0	5.9	0.16	12325 ± 253	None
Wela	0	6.0	0.16	14437 ± 92	None
Waraka	1	5.7	0.17	12300 ± 156	None
Wela	1	5.8	0.17	12598 ± 86	None
Waraka	2	5.6	0.17	11243 ± 82	None
Wela	2	5.8	0.17	12598 ± 940	None
Waraka	3	5.5	0.18	9723 ± 494	None
Wela	3	5.5	0.18	10625 141	None

a Varietal effects are significant ($P<0.05$)
b Storage effects are significant ($P<0.05$)
c Mean ± SE

The changes in the colour of endosperm of jak seeds are of interest from the consumer point of view. In both varieties, colour of the endosperm changed from light white yellow to dark white yellow, with increasing storage time in sand. This is due to the formation of mellanoidin pigments during storage (Feeney *et. al.*, 1982).

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