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ORIGINAL ARTICLE

Effect of Different Storage Structures on Biochemical Alterations in Seeds of *Pennisetum Americanum* (Linn.) During Storage

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ABSTRACT

Different field trips were made to five districts of Rajasthan for collection of seeds of Pennisetum americanum. The seeds were stored at room temperature for 3, 6, 9 and 12 months in six different storage structures viz., cloth bags, earthen pots, jute bags, paper bags, polythene bags, tin boxes and were studied. It was observed that total starch content and total protein content were found to decrease with increase in storage period while total soluble sugar, phenol content and amino acids increased with increase in storage period. The study also revealed that average percent reduction in total starch content and total soluble protein was maximum in seeds stored in jute bags and cloths bags as compared to other storage structures. Similarly, average percent increase in total soluble sugar, phenol content were maximum in seeds stored in juts bags and cloths bags and minimum in seeds stored in tin boxes. The present study therefore recommends that to store seeds in healthy state and to prolong the enhanced seed viability, seeds be stored in tin boxes.

Key Words: *Pennisetum americanum Seeds, Storage Structures, Total starch content, Total protein content, Total Soluble Sugar and Phenol Content*

INTRODUCTION

One of the basic needs of agriculture is the quality of seed, characterised by high viability and vigour. Chemical composition of seeds alters during storage due to microbial infection. The evaluation of viability, vigour and chemical composition of any seed is of utmost importance to judge the quality of seeds. Improper storage makes the seeds vulnerable to microorganisms (storage fungi and bacteria) which deteriorate the stored seeds both qualitatively and quantitatively. The microflora brings about a variety of biochemical changes. They alter starch, fatty acids, reducing sugars, non reducing sugars, insoluble nitrogen and protein contents of stored seeds.

Earlier, the objectives of plant pathological studies were mostly confined to the description and identification of causal organism and control measures of the disease but the approach has now been changed and the stress has shifted towards the understanding of host-parasite relationship through patho-biochemical studies. A greater knowledge of biochemistry of fungi pathogenic to plant is expected to aid in understanding the physiological reactions between the host and the parasite.

MATERIAL AND METHODES

The biochemical studies were carried out on seventeen seed samples of *Pennisetum americanum* collected from five districts of Rajasthan. Selecting one sample from each district, the seeds of each sample were stored in six different storage structures for a definite storage period. The seed samples were maintained in unsterilized conditions and the seed microflora was studied after every three months interval (3, 6, 9 and 12 months) of storage period in different storage structures. Simultaneously, studies on biochemical

alterations were carried out in the seeds stored in different storage structures and at different storage periods.
The amount of total soluble sugar was estimated by phenol sulphuric acid reagent method (Dubois *et al.*, 1951).The method of Mc Cready *et al.* (1950) was estimation of Total starch content. Total Phenol content carried out using the method of Bray and Thorpe (1954). Total soluble protein was estimated following the method of Lowry *et al.* (1951).

RESULTS

The results of the above study were compared with the results of seed samples collected at the time of harvest, which served as control (Table 1, Graph-2.1-2.2).

Total Soluble Starch Content:

In the present study, it was observed that the content of starch in the seeds decreased with the increase in storage period (Graph 2.1). The maximum average content of starch (19.14 mg/g) was recorded in seeds stored in tin boxes after 3 months of storage period while minimum average content of starch (10.31 mg/g) was recorded in seeds stored in jute bags after 12 months of storage period.
A maximum of 48.38% decrease was observed in sample no. Pa-30 stored for 12 months in jute bag and a minimum decrease of 7.00% was observed in sample no. Pa-19 stored for 12 months in tin box (Table 1).

Total Soluble Sugar:

Analysis of freshly harvested seeds stored in six different storage structures for total soluble sugar displayed a trend opposite to that of starch content i.e. with the reduction in starch content a simultaneous increase in the total soluble sugar was observed.
The graph 2.1 showed that the average content of total soluble sugar in the seeds increased with the increase in the storage period. The maximum average content of total soluble sugar (3.67 mg/g) was recorded in seeds stored in jute bags after 12 months of storage period while minimum average content of total soluble sugar (2.94 mg/g) was recorded in seeds stored in tin boxes after 3 months of storage period.
A maximum of 30.46% increase in total soluble sugar was observed in sample no. Pa-30 stored for 12 months in jute bag and minimum increase of 2.83% was observed in sample no. Pa-19 stored for 12 months in tin box.

Total Soluble Protein:

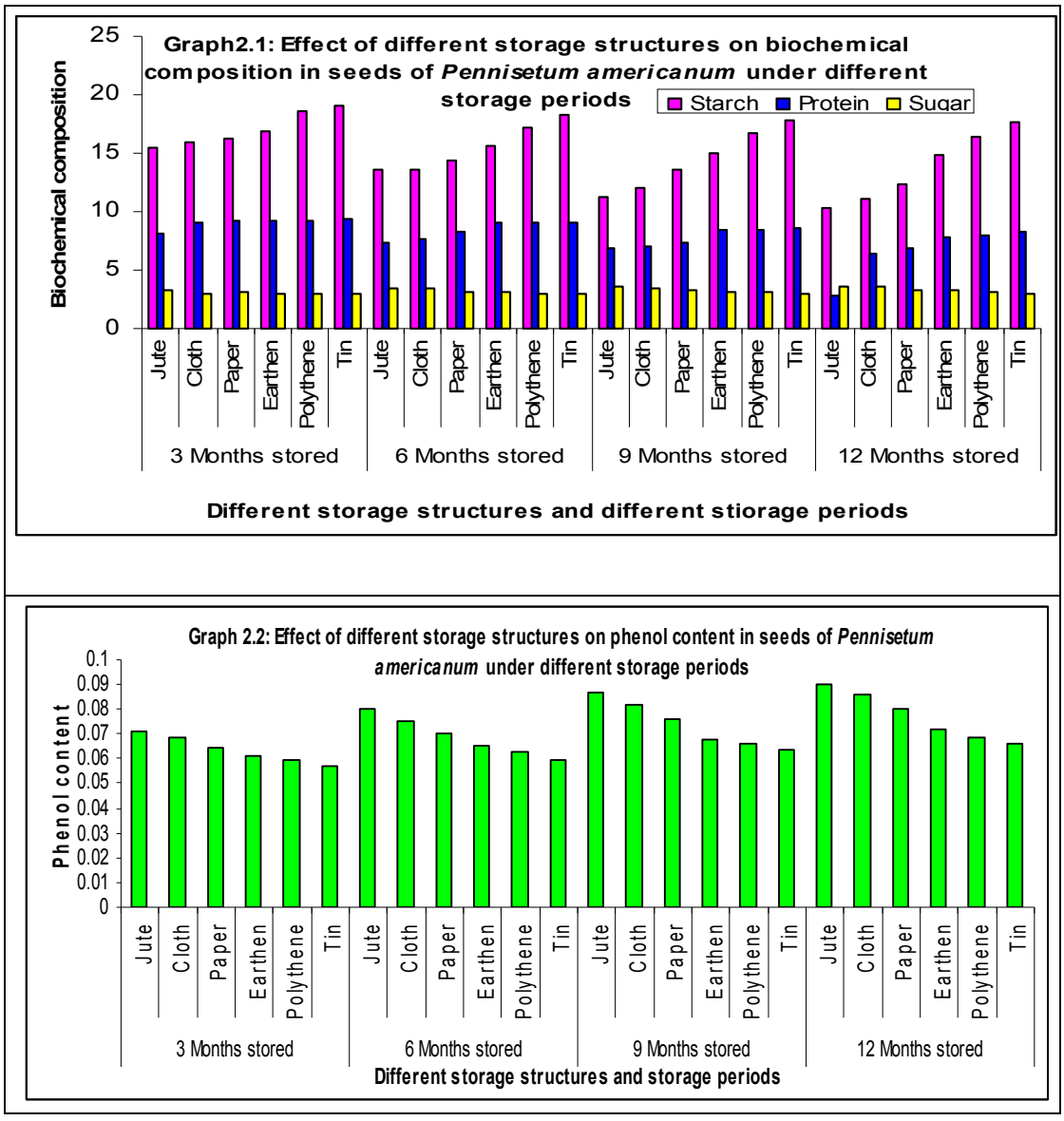
In the present study, it was observed that the content of total soluble protein in the seeds decreased with the increase in storage period (Graph 2.1). The maximum average content of total soluble protein (9.40 mg/g) was recorded in seeds stored in tin boxes after 3 months of storage period while minimum average content of total soluble protein (2.74 mg/g) was recorded in seeds stored in jute bags after 12 months of storage period.
A maximum of 78.63% reduction in total soluble protein was observed in sample no. Pa-30 stored for 12 months in jute bag and a minimum of 12.03% reduction was observed in sample no. Pa-19 stored for 12 months in tin box (Table 1).

Total Phenol Content:

Total phenol content showed an increased trend as the storage period advanced. The graph 2.2 showed that the average content of total phenol in the seeds increased with the increase in the storage period. The maximum average content of total phenol (0.090 mg/g) was recorded in seeds stored in jute bags after 12 months of storage period while minimum average content of total phenol (0.0574 mg/g) was recorded in seeds stored in tin boxes after 3 months of storage period.
A maximum of 71.66% increase in total phenol content was observed in sample no. Pa-19 stored for 12 months in jute bag and a minimum of 16.00% increase was observed in sample no.Pa-30 stored for 12 months in tin box.

DISCUSSION

The effects of storage structures and the storage conditions on the seeds are analysed by comparing the healthy seeds with storage seeds. The freshly harvested seeds are stored in different storage structures under the laboratory conditions. During storage, seeds undergo various alterations which included structural, physiological and biochemical changes. The incidences of fungi and bacteria reduce the quality of stored seeds both by colonization of the structure of seeds and by altering the biochemical quality. Thus it was considered necessary to investigate the biochemical changes taking place in the stored seeds. Investigations on biochemical changes in seeds of *Pennisetum americanum* are described below.



Carbohydrate:

Carbohydrates are the main source of carbon for the metabolic activities of the fungi which infect the seeds under storage conditions. Content analysis of the fungal and bacterial infected storage seeds was found to reduce during storage conditions.

It was observed that the carbohydrate content (starch) of the fungal infected seeds reduced during storage. The above results are in conformity with the reports of Singh *et al.* (1972) in seeds of *Sesamum indicum;* Singh *et al.* (1981) in seeds of *Cajanus cajan*;

Prasad and Pathak (1987) in seeds of cereals (wheat and maize); Dwevedi *et al.* (1987) ingram seeds; Dube *et al.* (1988) in seeds of wheat; Ray and Gangopadhyay (1991) in discoloured grains of rice varieties; Ragina and Rama (1992) in stored seeds of caraway; Saxena and Karan (1991) in sesame and sunflower seeds; Mukherjee *et al.* (1992) in groundnut seeds; Pandey and Prasad (1993) in seeds of Karanj; Paul and Mishra (1994) in maize seeds and Singh *et al.* (1996) in seeds of *Jatropha curcas*.

Schipper and Microcha (1969a) described reduction in starch content in infected beans. According to them, starch plays a major role during pathogenesis by supplying the necessary metabolites to the pathogen during penetration and spore formation. Golbchuk *et al.* (1956) reported that carbohydrate decomposition was due to the catabolic activity of the storage fungi. Reduction in starch content under pathogenesis has also been suggested by Manners (1974) to be due to increased activity of α-amylase enzyme. Vidyasekaran and Kandawamy (1972) and Wu (1973) have also reported depletion of starch with corresponding increase in amylase activity. Sinha (1979) and Prasad and Das (1985) stated that biodegradation of seeds could be due to utilization of host carbohydrate (starch) by the fungal organism for the synthesis of various metabolic products.

Table 1: Biochemical Contents (mg/g dry wt.) of Freshly Harvested Seeds of *P.americanum*

S.No.	Sample Number	Biochemical Content (mg/g dry wt.)			
		Total Soluble Sugar	Total Starch Content	Total Soluble Protein	Total Phenol Content
1	Pa-18	2.75±0.06	20.40±0.10	10.70±0.25	.066±0.04
2	Pa-19	2.82±0.01	20.00±0.04	10.30±0.10	.060±0.06
3	Pa-20	2.72±0.05	20.30±0.80	10.80±0.14	.066±0.07
4	Pa-21	2.90±0.25	19.30±0.06	9.50±0.20	.058±0.02
5	Pa- 22	2.79±0.12	20.10±0.03	10.50±0.18	.064±0.18
6	Pa-23	2.94±0.08	19.20±0.02	9.45±0.30	.055±0.20
7	Pa-24	2.74±0.15	2030±0.04	10.90±0.25	.070±0.03
8	Pa-25	2.89±0.04	19.40±0.05	9.50±0.06	.055±0.12
9	Pa-26	2.83±0.10	19.80±1.00	10.10±0.04	.060±0.48
10	Pa-27	2.86±0.06	19.50±0.15	10.00±0.80	.058±0.35
11	Pa-28	2.70±0.08	20.70±0.11	11.0±0.12	.071±0.17
12	Pa-29	2.75±0.12	20.50±0.01	10.60±0.15	.067±0.82
13	Pa-30	3.02±0.01	18.60±0.04	8.80±0.85	.050±0.10
14	Pa-31	2.80±0.00	20.00±0.08	10.30±0.09	.061±0.60
15	Pa-32	2.66±0.03	20.90±0.00	11.20±0.10	.073±0.11
16	Pa-33	2.50±0.18	21.20±0.85	11.30±0.80	.074±0.09
17	Pa-34	2.83±0.05	19.70±0.05	9.80±0.06	.058±0.45

In the present investigation, the total soluble sugar showed an increasing trend in the seeds of *Pennisetum americanum* during storage. This could be due to the fact that the invading fungi which colonize on seeds may break down the complex carbohydrate (starch) resulting in an increase in the total soluble sugar during storage (Vidyasekaran and Govindaswamy, 1968 and Mathur and Sinha, 1978). The degradation of starch content in infected seeds has been attributed to the activation of hydrolysing enzyme like amylase which converts starch into simple sugar (Vidyasekaran and Kandaswamy, 1972 and Bilgrami *et al.,* 1979).

It has been observed in the present study that starch content reduced more rapidly in seeds of *Pennisetum americanum* stored in jute bags and less in tin boxes after one year of storage. Similarly, total soluble sugar increased in seeds stored in jute bags and minimum

in tin boxes. The above data could be correlated with the fungal incidence which was much higher in seeds stored in jute bags than stored in tin boxes. Consequently, this might have led to more degradation of starch by the action of hydrolysing enzymes possibly α-amylase due to increased fungal incidence.

It was further observed that the reduction in starch content was more compared to the increase in total soluble sugar in seeds of *Pennisetum americanum.* This difference could probably be due to the simultaneous utilization of some of the sugars by pathogen itself. Similar results have been obtained by Vidyasekaran and Kandaswamy (1972) in *Phaseolus aureus,* Parma *et al.* (1980) in coconut kernel and Agarwal (1983) in *Phaseolus vulgaris.*

Total Soluble Protein:

The results of the biochemical tests conducted for the estimation of total soluble protein in the seeds under storage showed reduction in the total protein content during storage. The results were firmly supported by the findings of Prasad and Pathak (1987) in cereals; Ray and Gangopadhyay (1991) in rice grains; Saxena and Karan (1991) in sesame and sunflower seeds; Arulnandhy and Senanayake (1991) and Mukherjee *et al.* (1992) in seeds of groundnut; Ragina and Raman (1992) in Caraway seeds; Chin *et al.* (1993) in seeds of soybean; Pandey and Prasad (1993) in Karanj seeds; Singh *et al.* (1996) in *Jatropha curcas* seeds; Dixit *et al.* (1997) in groundnut seeds and Ushamalini *et al.* (1998) in cowpea seeds.

The reduction in protein content could be due to the capability of fungi to produce proteolytic enzymes (Steward 1965 and Vidyasekaran *et al.* 1973). Further, these fungi deplete the proteins to low molecular weight components and decomposition of the latter, in the formation of free amino acids. Degradation in protein content of seeds during storage has also been reported by Cherry (1983).

It was also observed that total soluble protein decreased more in seeds of *Pennisetum americanum* stored in jute bags as compared to other storage structures. This could again be expected to be due to the increased fungal incidence in seeds stored in jute bags and the increased proteolytic activity of fungi.

Total Phenol Content:

The total phenol content of freshly harvested seeds and infected (stored) seeds were compared and it was revealed that the phenol content increased with the increase in the storage duration (from 3, 6, 9 and 12 months).

Similar results of increasing phenolic content in the seeds during storage was observed by Singh and Srivastava (1988) in moth bean; Krishna and Reddy (1988) in seeds of maize; Dwivedi (1990) in seeds of chick pea and Ray and Gangopadhyay (1991) in discoloured rice grains.

In the present investigation, increase in phenol content in stored seeds in comparison to freshly harvested seeds may be due to a number of factors which include enhanced synthesis of phenol, translocation of phenolics to the site of infection and hydrolysis to phenolic glycosides by fungal glycosidases to yield free phenols (Srivastava and Roy, 1994). It was observed that seeds stored in jute bags showed maximum increase in total phenol content as compared to other storage structures. The higher phenolic content in seeds stored in jute bags could be due to higher fungal incidence (infection). Since, seed moisture content was higher in jute bags compared to other storage structures and hence becomes conducive to more fungal incidence. Similar observations have also been made by Farkas and Kirlay (1962) who reported that phenol contents are higher in deteriorated seeds as a result of fungal invasion than in freshly harvested ones. Duraiswamy and Mariappan (1983) also reported an increase in phenol content in infected purple grain of rice.

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