

STORAGE STUDIES ON PACKAGED SUGAR

Jute, PP and HDPE woven sacks were used for the study. The sponsor supplied the packaging materials. Sugar was packed in 1kg packets of PP and HDPE woven sacks while 10kg sugar was packed in Jute sacks. Accelerated storage (38⁰C, 92% RH) studies were not undertaken as sugar was found to pickup moisture even under normal packaged condition during storage. Therefore, the packages were stored only under ambient condition.

Sugar samples were drawn at monthly intervals and evaluated for moisture pickup and sensory qualities in terms of appearance and odour. The studies were carried out for a period of six months.

The result of the studies has shown that there was no significant difference in moisture content, colour and odour of the sugar samples stored in PP and HDPE woven sacks. The quality of samples was comparable to that of sugar packaged in Jute sacks.

It is concluded from the storage studies that PP and HDPE woven sacks could be used for packaging of sugar. Quality of sugar when packed in plastic woven sacks was not adversely affected during storage.

ODOUR EVALUATION

Methodology

Odour evaluation was carried out for the following samples.

1. PP and HDPE woven sacks
2. Wheat, Rice, Paddy and Sugar before packaging.
3. Wheat, Rice, Paddy and Sugar packaged in PP and HDPE woven sack and stored at ambient and accelerated conditions.

The samples were drawn at monthly intervals.

Odour evaluation was conducted using E-Nose which is a sophisticated instrument designed to mimic human nose. The E-Nose is based on a metal oxide sensor array which due to specific reactions to various kind of molecules., produces an olfactive picture or fingerprint from an odour. Metal oxide sensor devices are based on doped or undoped metal oxides.

Head space volatiles of the sample taken in a sample holder are carried by zero air into the detector system of the E-Nose. The volatiles come in contact with the sensors and are adsorbed. The principle of detection is based on conductivity measurements; in the presence of a combustible gas or odour, the oxygen species which are adsorbed on the metal oxide react and removed from the surface. As a result the conductivity of the metal oxide film changes. Further these values are subjected to statistical analysis.

E-Nose Analysis

E-Nose analysis was performed by using 25g of sample taken in a glass bottle provided by the manufacturer. The bottle was kept in the slot provided and head space volatiles were allowed to accumulate for 10 minutes. Then the zero air was let into the sample bottle and the outlet was opened to allow the volatiles to be carried to the detector of E-Nose.

Test conditions

Acquisition time (s)	120
Acquisition period (s)	0.5
Injection time (s)	60
Zero air flow rate (ml/min)	150

For one sample 5 readings were recorded with a time gap of 2 minutes. This provides 5 sets of readings for each sample.

Statistical Analysis of E-Nose

The data pertaining to sensor responses need to be further processed to obtain meaningful results. This was achieved by carrying out multivariate analysis like PCA, DFA or SIMCA using the software provided by the manufacturer to explore the data from the samples. The final report of the samples is displayed in a two dimensional plot showing the group of points. The first axis explains the variance explained will be displayed on the respective axis automatically by the software provided by the manufacturer. The interpretation will be drawn based on their relative position of the groups. The E-Nose provides patterns of volatile organic compounds that could be used to perform comparison and clarification study. Using automated pattern recognition algorithms within the software allows quick comparison and identification of samples. Unsupervised learning techniques like Principal Component Analysis (PCA) are used to explore the data and assess discrimination performances. PCA determines subspaces that summarizes the information contained in the initial database. The two main objectives are reducing the number of variables and eliminating redundancy. Sample presentations are performed in a two or three dimension spaces relative to the chosen components (C_1 to C_n). Components are classified depending on the level of identification they produce. This analysis will help in

- Assessment of the similarities between samples.
- Finding out which samples are different or similar and
- Are they separated in homogeneous groups.

DISCUSSION

E-Nose was used to get the odour pattern of the packaging material namely, High Density Poly Ethylene (HDPE) woven sack and Poly Propylene (PP) woven sack as well as the odour profile of paddy, rice, wheat and sugar packed in these bags. Fig 1 gives the differentiation in the odour profile of packaging materials. From the figure it can be seen that the odour of HDPE and PP are of different nature as they form two different clusters. Odour of jute bags form another cluster. In order to find out whether the packaging material imparts any odour to the food material, model test was done. In this test packaging material and wheat taken in the ratio of 1:1 was subjected to odour analysis by E-Nose. Aroma profile of this was compared with those of wheat alone and the packaging material. Fig 2 indicates that in presence of the packaging material the odour of wheat changes. In this figure wheat odour (1) and odour of wheat + PP (3) were separated from one another which clearly reflects the change in the wheat odour as it comes in contact with packaging film. However, this experiment was designed as a model experiment wherein disproportionately high quantity of packaging material was in contact with wheat. From the results given in Figure 1 and 2 it can be concluded that

- i. HDPE, PP and Jute have distinct odours
- ii. Wheat odour is altered if it is in intimate contact with large quantity of packaging material.

In the actual practice food products such as wheat, paddy etc come into contact with the packaging material to a limited extent; only the outer most layer is in contact with the packaging film. To assess the extent of odour changes the odour testing of food materials packaged in HDPE and PP sacks and stored under standard conditions was done at regular intervals. Some of the salient findings are discussed here. Figure 3 gives the PCA biplot of odour analysis of paddy packaged in HDPE woven sack and stored under ambient conditions. Initial odour profile (I),

odour profile of samples stored for 3 months (A) and stored for 6 months (B) formed separate groups. This shows that on storage the odour of paddy change but this could be due to certain physicochemical changes taking place in paddy during storage. Since the odour pattern did not show any shift towards that of HDPE it can be deduced that paddy did not pickup any significant odour from HDPE under ambient storage condition. Similar trend of results is shown (Fig 4) by paddy in PP woven sack stored under ambient condition. Figure 5 and 6 gives the odour pattern of paddy stored under accelerated condition in HDPE and PP woven sack. The samples developed off odour beyond 30 days of storage. Therefore odour analysis was done at the end of 15 days and 30 days of storage. Stored sample odours were distinguishable from the odour of initial sample but were not significantly affected by the odour of packaging material. Odour changes in packaged rice at ambient condition did not show any definite trend upto 6 months of storage (Fig 7 and 8). PCA biplot (Fig 9 and 10) pertaining to accelerated storage of packaged rice did not show any significant effect of packaging material on rice upto 30 days of storage. Beyond 30 days the sample had developed off odour due to physicochemical changes occurring at accelerated condition of 38°C and 92% RH. Packaged wheat stored upto 6 months showed slight odour pickup from the packaging material (Fig 11 and 12) as shown by the relative position of odour profiles. Sugar did not show any definite or distinct trend of odour pickup during storage upto 6 months under ambient condition (Fig 13 and 14).

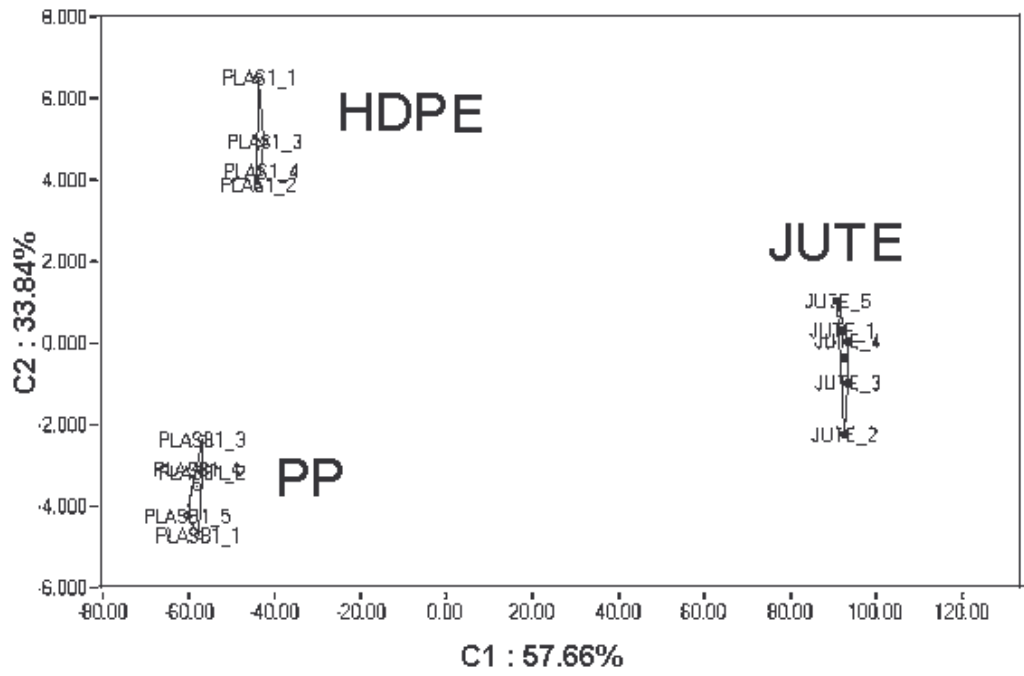


Fig. 1 PCA biplot: Odour analysis of packaging materials

HDPE - High Density Poly Ethylene
 PP - Poly propylene

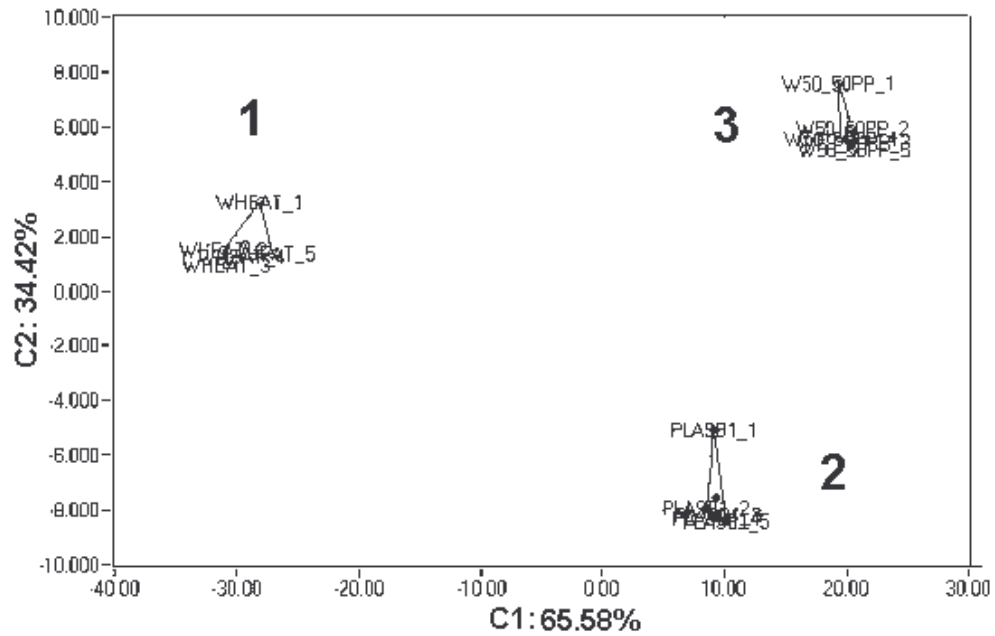


Fig. 2 PCA biplot: Odour analysis of wheat, PP and wheat + PP

1. Wheat
2. Packaging material – Poly propylene
3. Packaging materials and wheat (50:50)

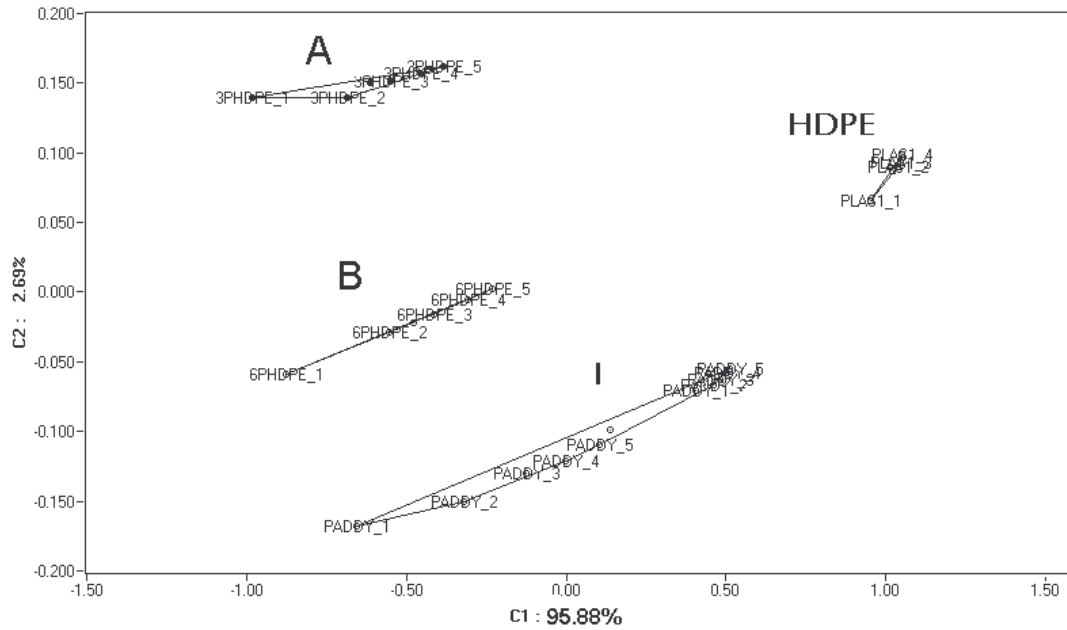


Fig. 3 PCA biplot: Odour analysis of paddy packaged in HDPE woven sack (Ambient)

- HDPE - High Density Poly Ethylene
- I - Initial
- A - Stored for 3 months
- B - Stored for 6 months

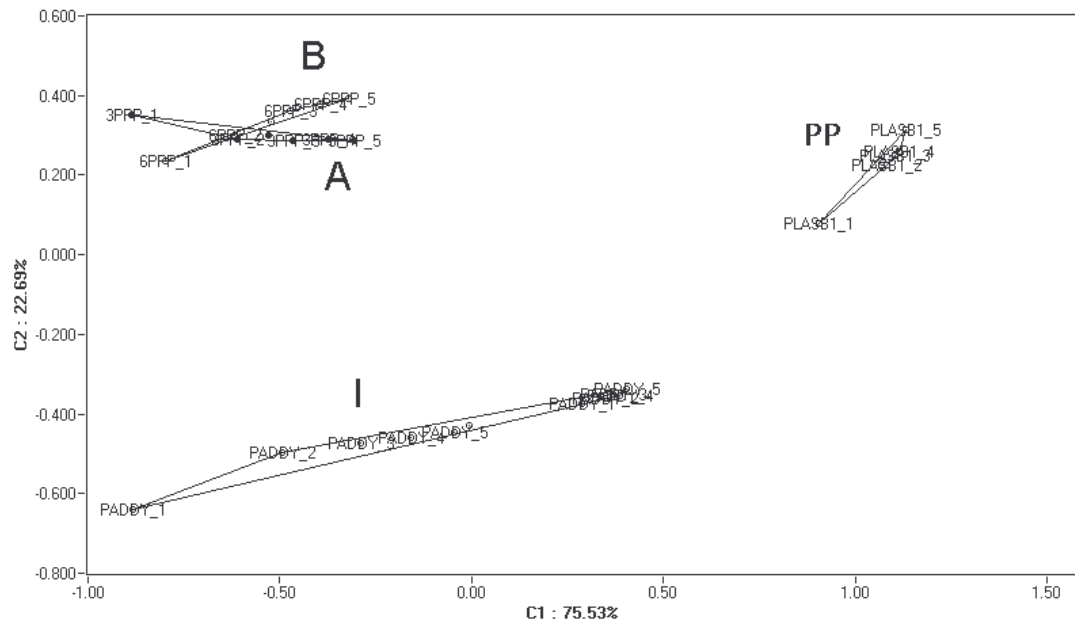


Fig. 4 PCA biplot: Odour analysis of paddy packaged in PP woven sack (ambient)

- PP - Poly Propylene
- I - Initial
- A - Stored for 3 months
- B - Stored for 6 months

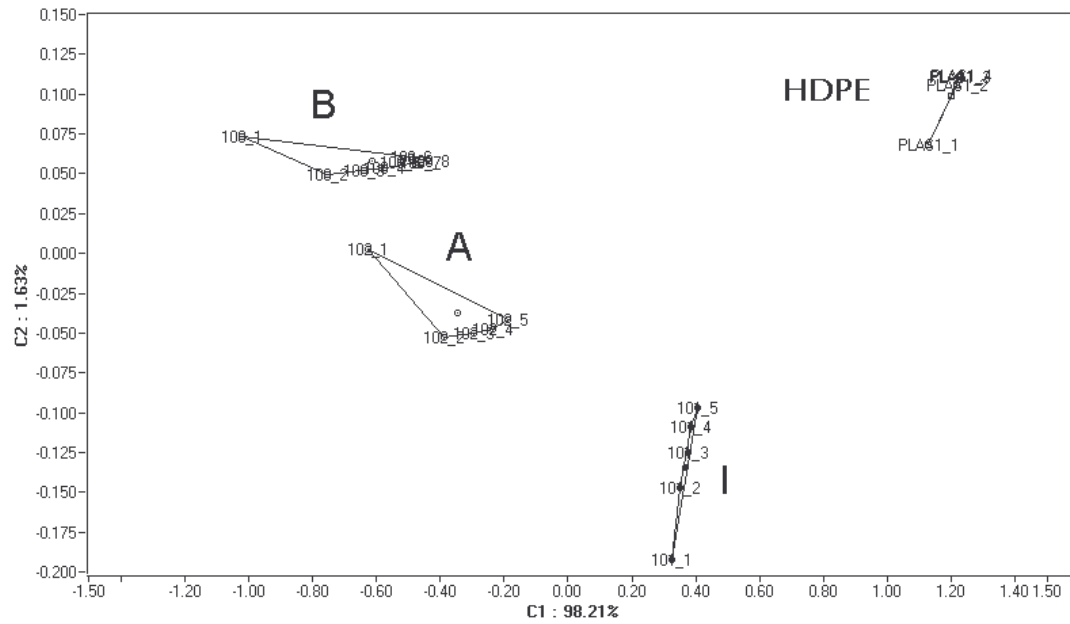


Fig. 5 PCA biplot: Odour analysis of paddy packaged in HDPE woven sack (Accelerated)

- HDPE - High Density Poly Ethylene
- I - Initial
- A - Stored for 15 days
- B - Stored for 30 days

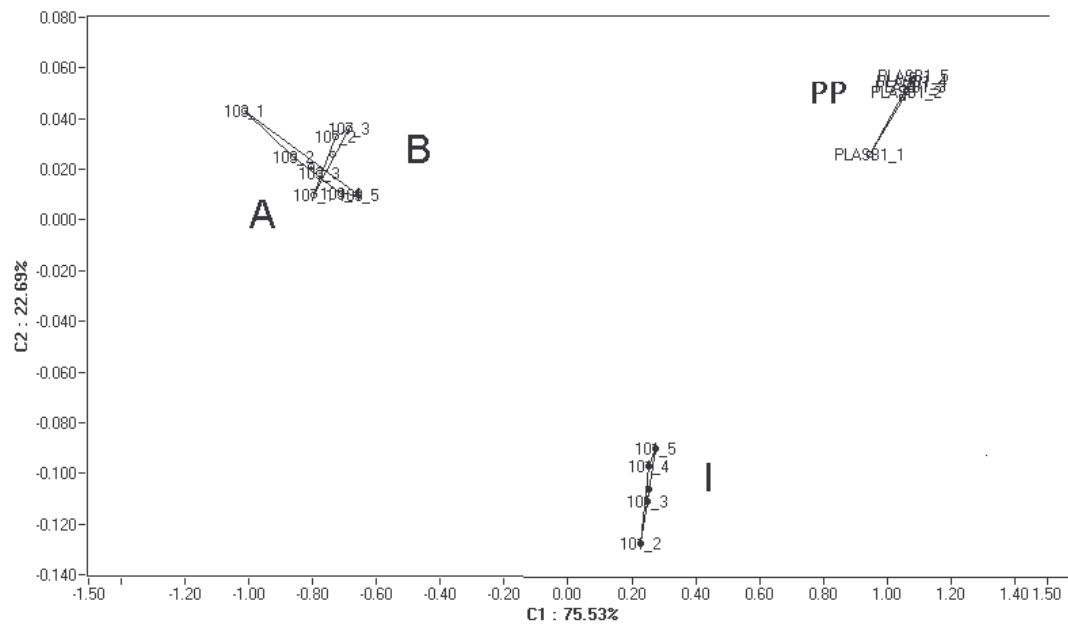


Fig. 6 PCA biplot: Odour analysis of paddy packaged in PP woven sack (Accelerated)

- PP - Poly Propylene
- I - Initial
- A - Stored for 15 days
- B - Stored for 30 days

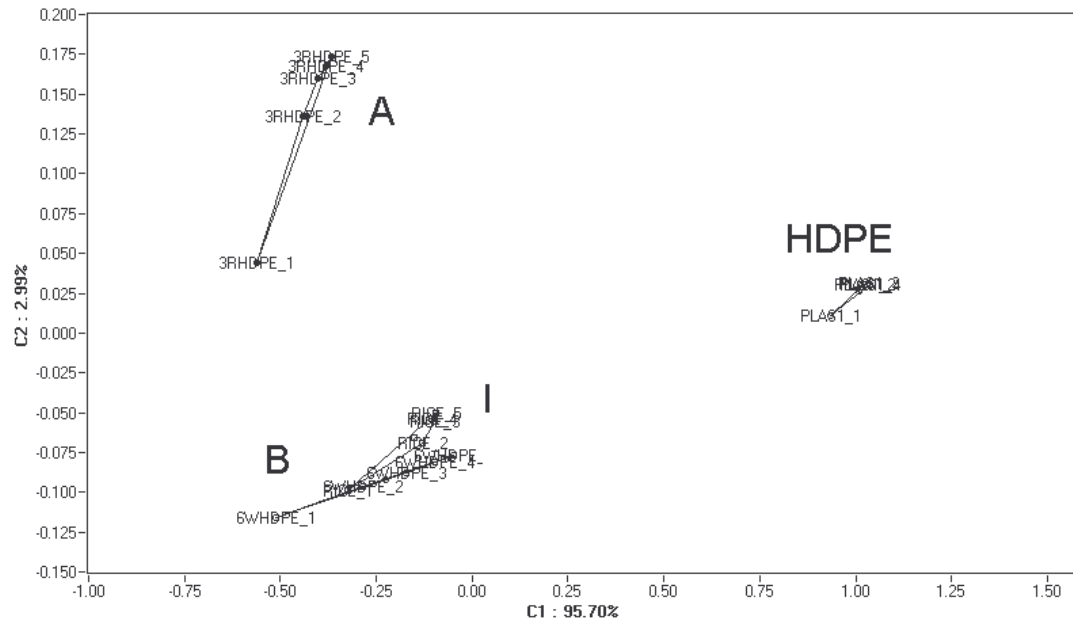


Fig. 7 PCA biplot: Odour analysis of rice packaged in HDPE woven sack (Ambient)

- HDPE - High Density Poly Ethylene
- I - Initial
- A - Stored for 3 months
- B - Stored for 6 months

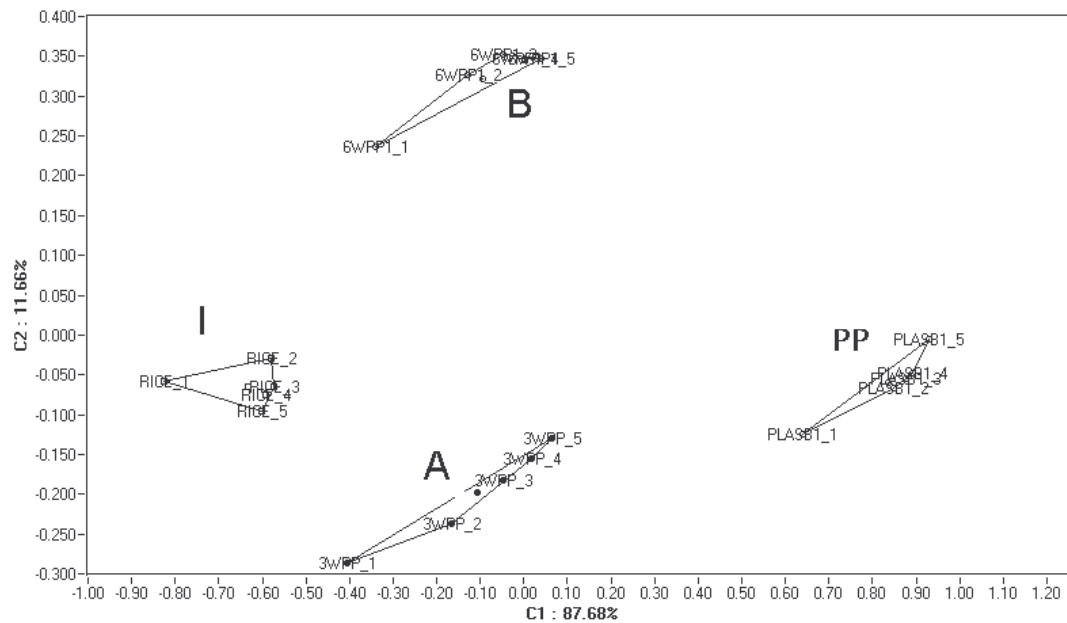


Fig. 8 PCA biplot: Odour analysis of rice packaged in PP woven sack (Ambient)

- PP - Poly Propylene
- I - Initial
- A - Stored for 3 months
- B - Stored for 6 months

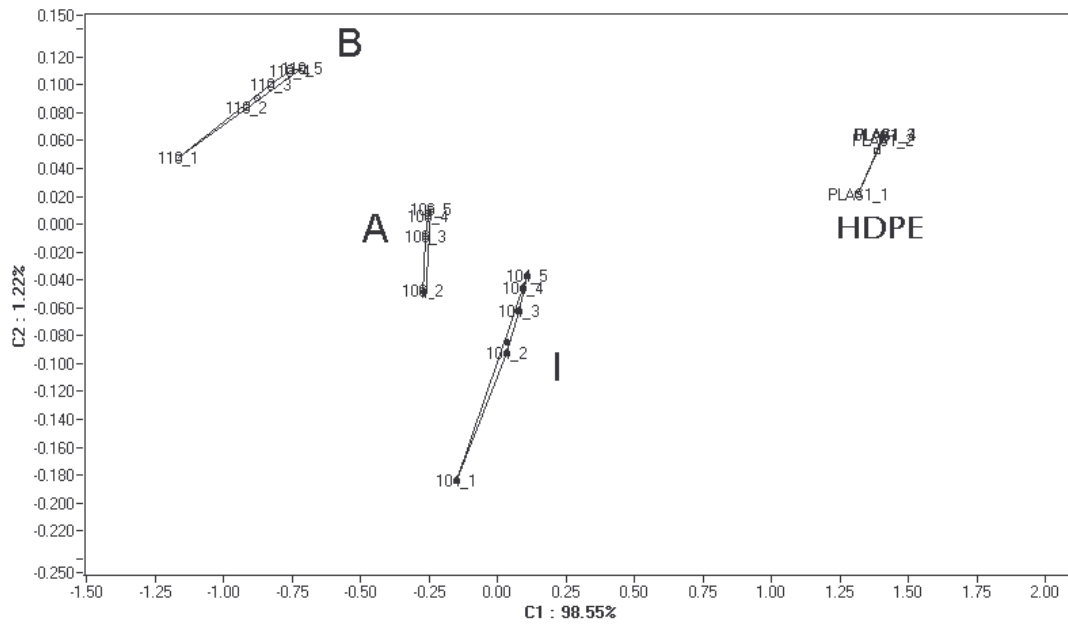


Fig. 9 PCA biplot: Odour analysis of rice packaged in HDPE woven sack (Accelerated)

- HDPE - High Density Poly Ethylene
- I - Initial
- A - Stored for 15 days
- B - Stored for 30 days

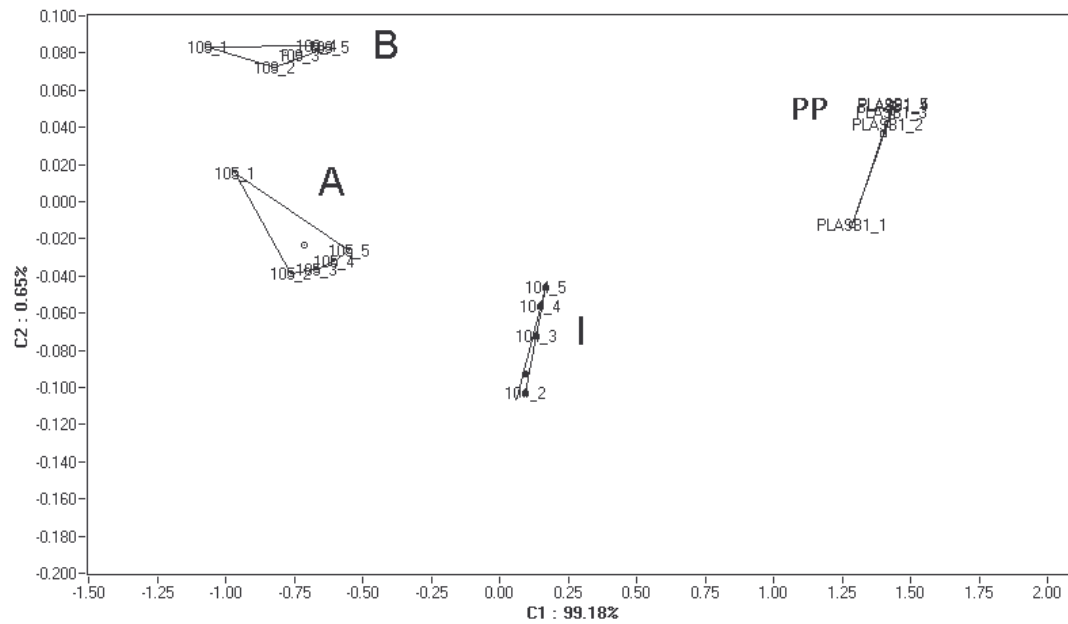


Fig. 10 PCA biplot: Odour analysis of rice packaged in PP woven sack (Accelerated)

- PP - Poly Propylene
- I - Initial
- A - Stored for 15 days
- B - Stored for 30 days

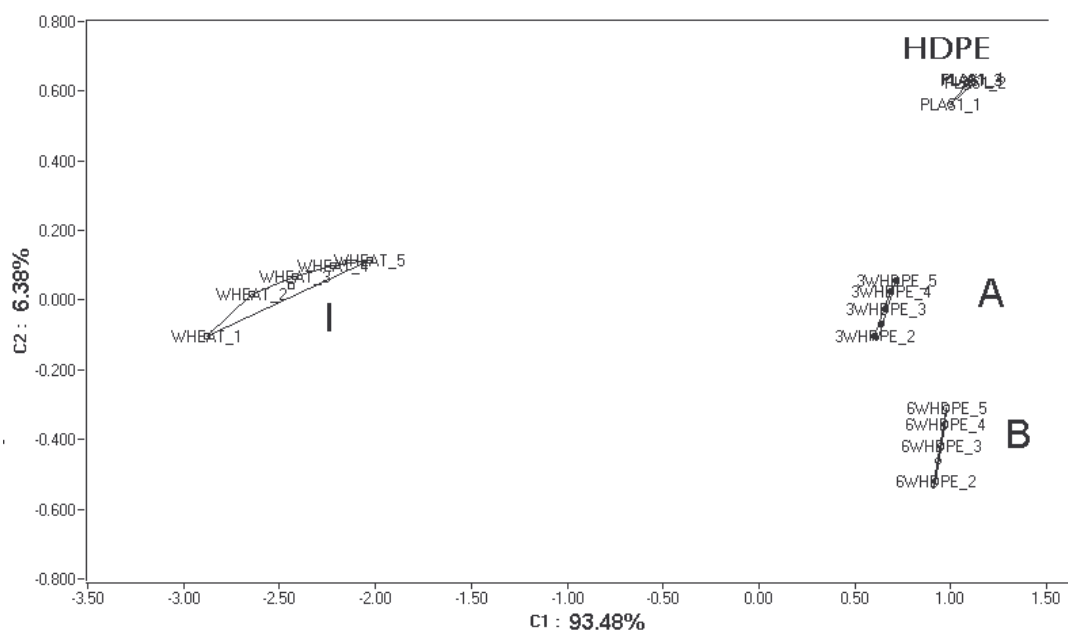


Fig. 11 PCA biplot: Odour analysis of wheat packaged in HDPE woven sack (Ambient)

- HDPE - High Density Poly Ethylene
- I - Initial
- A - Stored for 3 months
- B - Stored for 6 months

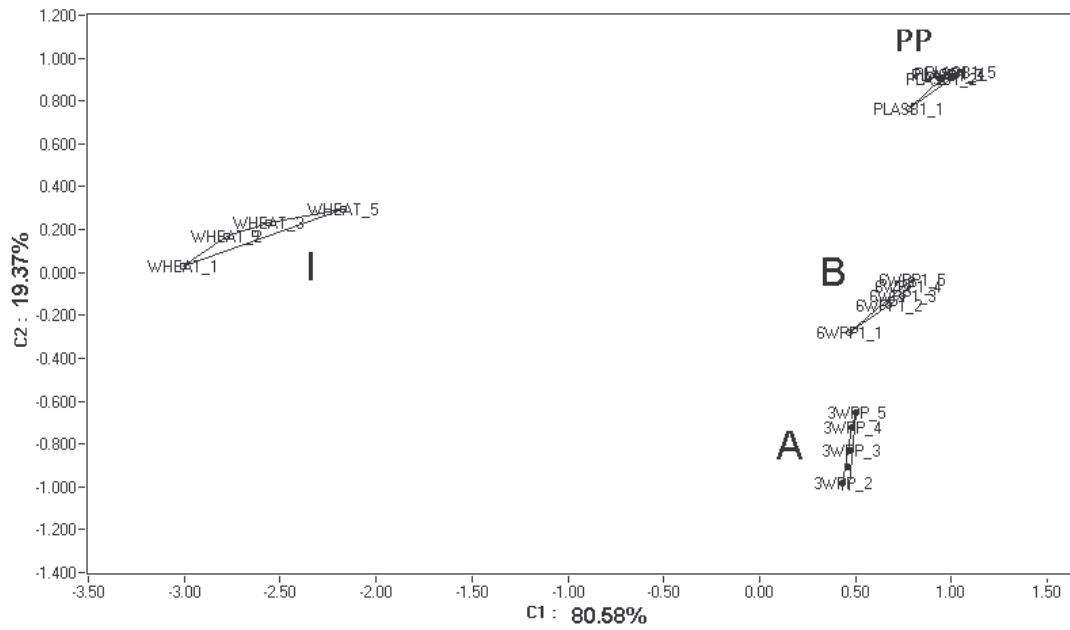


Fig. 12 PCA biplot: Odour analysis of wheat packaged in PP woven sack (Ambient)

HDPE - Poly Propylene

I - Initial

A - Stored for 3 months

B - Stored for 6 months

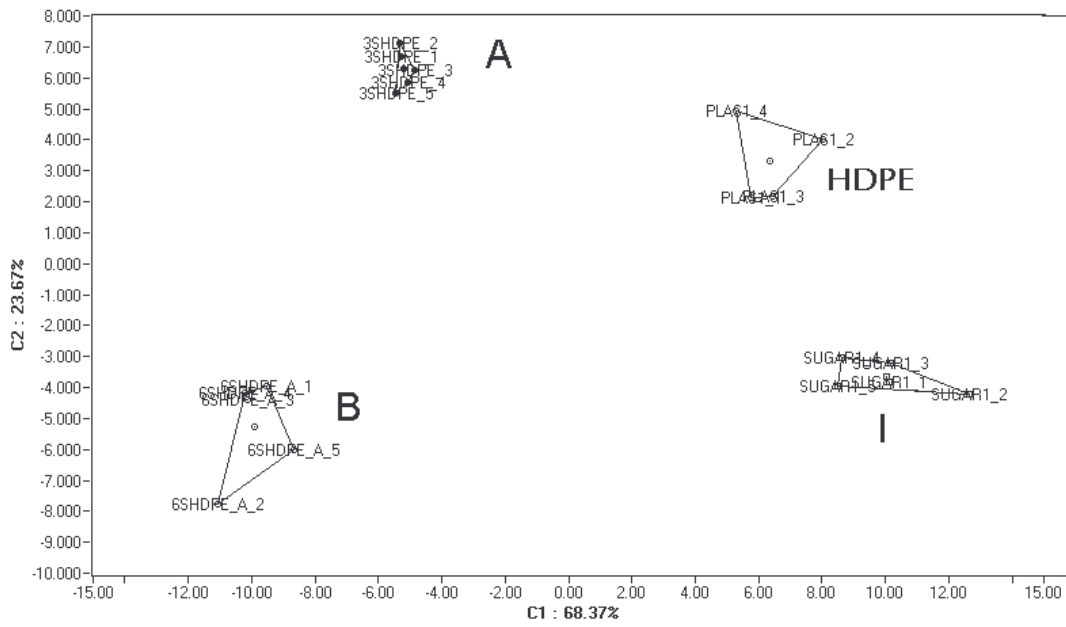


Fig. 13 PCA biplot: Odour analysis of sugar packaged in HDPE woven sack (Ambient)

- HDPE - High Density Poly Ethylene
- I - Initial
- A - Stored for 3 months
- B - Stored for 6 months

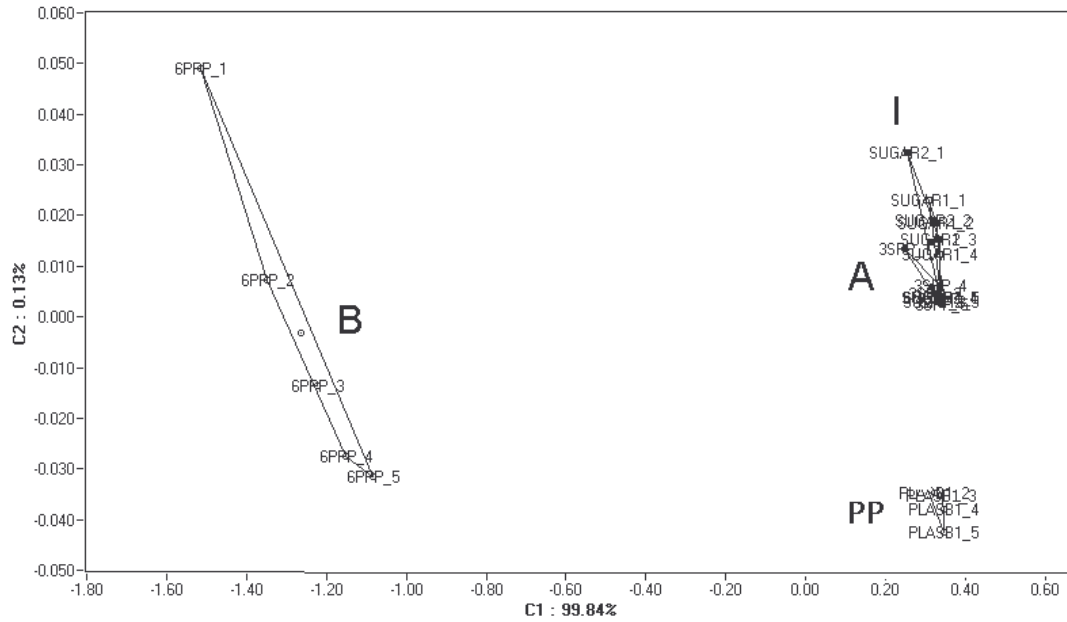


Fig. 14 PCA biplot: Odour analysis of sugar packaged in PP woven sack (Ambient)

- PP - Poly Propylene
- I - Initial
- A - Stored for 3 months
- B - Stored for 6 months