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Ventilated storage of groundnut in metal Bin and gunny bag storage

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Abstract
A comparative study of ventilated storage of groundnuts with traditional bag storage was done. The biochemical changes in groundnut was determined in both methods for 60 days. The ventilated storage bin was of 50 kg capacity and was fabricated with 2mm thick mild steel. In gunny bag storage, the groundnut pods were stored in ambient condition and for ventilated storage bin, the aeration was given by a blower at the rate of 0.04m/s for 1 hour during daytime for the period of 60 days. The initial moisture content of groundnut observed to be 6.5% db., After 60 days, it is increased to 8.2% db., in ventilated bin and 10.5% db in gunny bag, respectively. The average temperature of groundnut in ventilated bin and gunny bag storage were observed as 27.6±0.61°C and 30.14±1.64°C respectively. The initial protein, starch, oil, free fatty acid and peroxide value of groundnut were observed as 24.5%, 11.88%, 45.8%, 2.78% and 2.24 mEqu/kg. After 60 days of storage, the protein, starch and oil content decreased to 23.1%, 9.7% and 44.1%, in ventilated storage and 21.5%, 8.9%, and 42%, in gunny bag storage respectively. Free fatty acid and peroxide value of groundnut were increased after 60 days of storage to 3.3% and 3.98 mEqu/kg in ventilated storage and 4.2% and 5.65mEq/kg in gunny bag storage respectively.

Keywords: Groundnut, ventilated bin, gunny bag and nutrient composition

Introduction
The world production of groundnut is approximately 44,041,913 tonnes per annum. India being the second largest producer in the world with 6,857,000 tonnes, covers nearly 45% of cultivated area and accounts for 55% of total oil seed output (www.atlasbig.com). Estimated annual grain loss from harvest to consumption is approximately 10% of the total production. Production of aflatoxin due to invasion of the fungus *Aspergillus flavus*in groundnut pod and kernel is a serious problem in the trade of groundnuts in the international market, which has seriously hampered the export business of developing countries (Pandey *et al*., 2019) [12]. During traditional storage, the groundnuts are subjected to mold growth, pest and rodent attack importantly moisture content which results in quick spoilage. The challenge is to maintain the quality is an increased risk of deterioration during storage. To maintain the quality of groundnut aeration is required to cool the temperature. Increase in temperature increases the growth of storage pest. Aeration is a process of moving small volumes of air through grain or seed to cool and ventilate the material and maintain quality. Aeration conditions grains by lowering the temperature of the material and equalizing the temperature within the storage bin (John *et al*., 2015). This prevents moisture migration and improves the quality of the groundnut. As groundnut is a major source of oil, protein and starch the changes after storage were observed.

Materials and Methods
Ventilated Storage bin
The cylindrical bin with a diameter of 50 cm and a height of 120 cm was designed with a perforated plate at the bottom. The conical bottom of the bin, with dimensions of 22.5 diameters and 12.5 cm height, was designed to provide uniform air distribution inside the bin. Brass nozzles were provided at 20 cm intervals to measure the pressure difference in the cylindrical bin. For stability, a square frame and stand with dimensions of 90 cm height and 54cm width were fabricated. The bulk density and volume of groundnut to be stored inside the bin were used to determine the size of the bin. The storage capacity of the bin was 50 kg.A blower was used to supply the atmospheric air inside the bin. Considering the air flow resistance and pressure drop offered by the groundnut, as well as pressure losses due to pipe

joints and bends, a 0.5hp single face blower with an air velocity of 1 ms-1 and an air flow rate inside the bin of 0.05 m3s-1 was used for this study. A thermocouple was used to measure the temperature inside the bin at three different points: the bottom, the middle, and the top. The temperature inside the gunny bag was measured using USB data loggers.

Groundnut
Groundnut pods of variety VRI 8 were procured from Regional Research station, Vridhachalam. It was ensured that grains were clean, free of dirt, broken and other foreign matter. 50 kg capacity Mild steel Ventilated bin was designed and constructed. Gunny bag purchased from local market, Coimbatore. Two different storage is considered as a treatment. For every 15 days interval, various biochemical analysis namely protein, starch, oil, free fatty acid, peroxide were carried out.

Moisture content
5g sample was weighed in a plate and kept in hot air oven for about 2hrs (AOAC 1990) [1]. The temperature of hot air oven is maintained at 130-132 ºC. After this, the sample is taken out and cooled in desiccators. Final weight is measured. The moisture is calculated using, Moisture content (% dry basis) = (final weight- initial weight)/ (Weight of the sample) ×100

Physical dimension
The physical dimension namely length, breadth and width of the groundnut pods were determined. The dimensions were measured using a Vernier slide calliper with an accurate reading. The average diameter calculated using arithmetic mean diameter (D_a) and geometric mean diameter (D_g) of the groundnut pods and kernel were calculated by using following relationship (Dash *et al*., 2008) [3]

$$D_a = \frac{L+W+T}{3}$$

$$D_g = (LWT)^{1/3}$$

whereas, L- Length, W- width, T- Thickness

Sphericity
Sphericity of groundnut pods was calculated by using the following relationship (Mohsenin,1986) [10]

$$\Phi = \frac{(LWT)^{⅓}}{L}$$

Surface area
The surface area of groundnut pod sampleswere found by the relationship
$S = \pi D_g^2$

Where,
S= Surface area in cm^2
D_g= Geometric Mean diameter

Bulk density
Bulk density was determined by filling the groundnut pods/Kernels into a container and weighing the contents, suggested by (Mohsenin, 1986) [10]. It was calculated using

$$\text{Bulk density } (\rho_b) = \frac{M}{V}$$

True density
True density is defined as ratio of weight of kernel/ pods to the volume of the pods suggested by (Mohsenin, 1986) [10]. It was calculated by the following formula

$$\text{True density} = \frac{Mass\ of\ the\ displaced\ water}{Volume\ of\ water}$$

Porosity
Porosity of groundnut pods was determined by the value obtained from bulk density and true density in accordance with the following equation (Sahay and Singh, 1996) [14]

$$\text{Porosity (\%)} = 1 - \frac{Bulk\ density}{True\ density} \times 100$$

Co-efficient of friction
The co-efficient of friction was calculated for mild steel by the formula given by (Sahay and Singh, 1996) [14]

$$f = \frac{F}{W}$$

Where, f is the co-efficient of friction, F is the force of friction and W is the force normal to the surface contact.

Angle of repose
Angle of repose is the angle between the base and slope of the cone formed on a free vertical fall of the material to a horizontal plane. It can be calculated by using the formula $\theta = \tan^{-1}(\frac{2H}{D})$
Where, θ is the angle of repose, H is the height of cone formed and D is the diameter of the platform. This method was suggested by (Kleinhans *et al*., 2011) [6].

Table 1: Physical properties of groundnut

S. No	Properties	Pods	Kernels
1	Length	31.58 ±2.5	12.08±1.09
w2	Width	13.54±0.84	8.24±1.8
3	Thickness	11.54±0.63	8.68±1.91
4	Arithmetic Mean Diameter	18.88±2.5	17.024±2.54
5	Geometric Mean Diameter	9.66±1.05	9.52±1.07
6	Sphericity	0.61 ±0.93	0.77±0.12
7	Bulk Density	255.26±10.40	549.03±9.57
8	True Density	536.8±79.96	853.95±22.54
9	Porosity	44.03±3.62	41.03±1.22
10	Angle of repose	30.74±3.78	36.02±3.09

Extraction of Oil
The oil content in sample is analysed using soxhlet apparatus. 10g sample is taken in thimble and 80ml of petroleum ether is taken in 100ml flask. The apparatus is run for about2hrs. After 1 hrs of operation, the solvent is evaporated by keeping in hot water bath and for 1hr in hot air oven. Then the flask is cooled in desiccators and weighed. The oil content is obtained
% Oil yield = W_1-W_2/W_1 *100
Where, W_1- Sample weight initially placed in the thimble and W_2- Sample weight after dried in the oven (Natarajan *et al*. 2003) [11].

Protein Content
The protein content was determined using the method proposed by (Lowry *et al.*, 1951) [8] by hydrolyzing the protein and estimating the amino acid that gives the exact quantification of protein.

Starch Content
The estimation of starch content was done using acid hydrolysis method described by (Yang *et al*., 2019) [17].

Free fatty acid Content
The free fatty acid content in groundnut was determined by titrimetric method described by (Kupwade *et al*., 2019) [7].

Peroxide value
Peroxide value was evaluated according to AOAC (1990) [1].

Statistical Analysis
Quality changes data obtained from groundnut stored in gunny bag and ventilated bin were analysed using the statistical software SPSS version 22 and the results were represented below.

Results And Discussion
Two storage structures were used for this study. One is Gunny bag and other is Ventilated storage bin. The quality changes in the gunny bags stored material were based on weather condition. In Ventilated storage bin, the changes were based on the aeration given inside the bin.

Moisture changes in groundnut in ventilated bin and gunny bag during storage
The variation in moisture content of groundnut sample stored in both ventilated bin and gunny bag at room temperature shown in Fig 3.1. The samples were investigated for a storage period of 60 days. During the entire storage, the moisture value was increased with increasing storage period. The moisture content was found to increase from 6.5 to 8.2 in ventilated bin and 6.5 to 10.5 in gunny bag storage respectively. The increase in moisture content is due to the hygroscopic nature of the grains by the external humidity in environment (Domenico *et al*., 2015) [4]

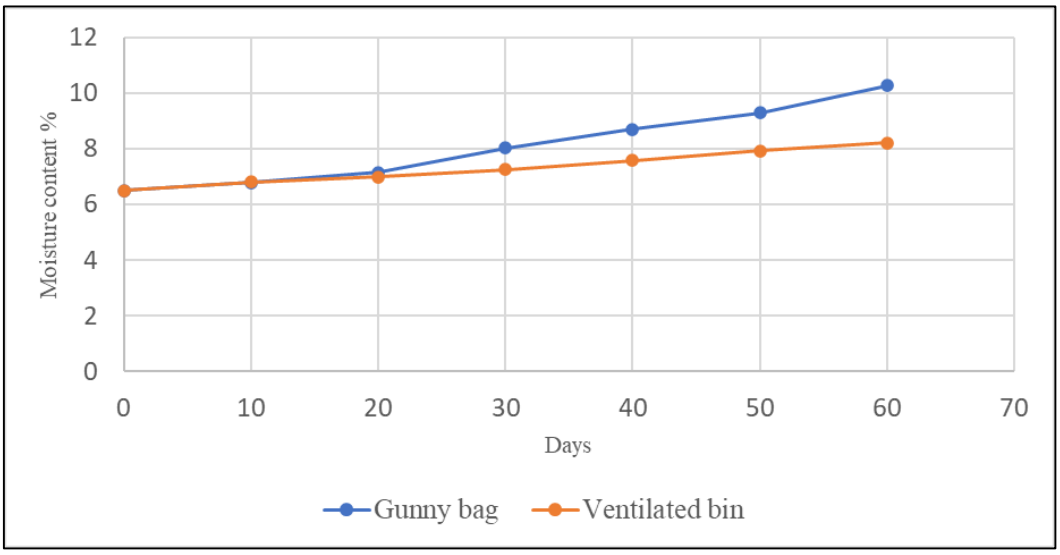

Fig 3.1: Moisture content changes in groundnut in gunny bag and ventilated storage

Temperature changes in groundnut in ventilated bin and gunny bag during storage
The temperature of ventilated bin storage and gunny bag storage were recorded at three different levels (Top, Middle and Bottom). The average temperature of ventilated bin and gunny bag storage was found to be 27.6±0.619°C and 30.14±1.64°C. The temperature deviation in gunny bag was high when compared to ventilated storage.

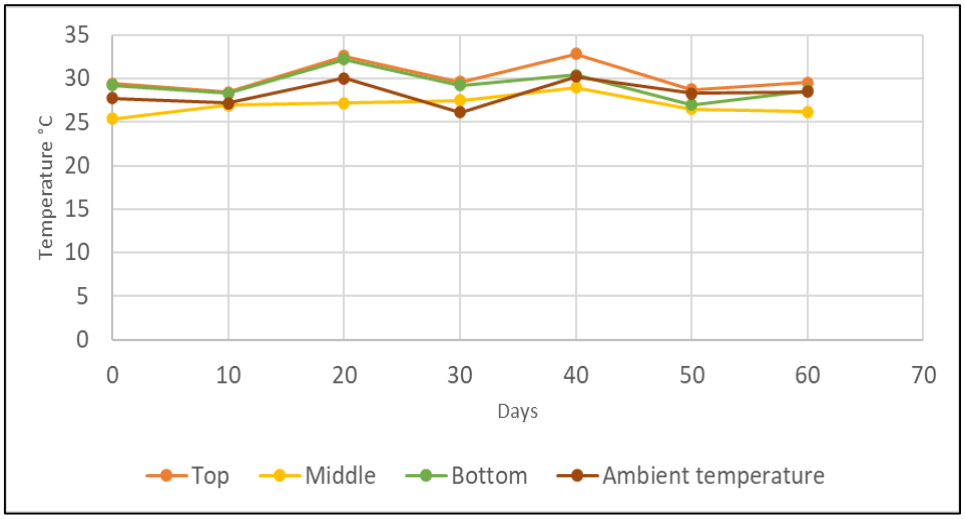

Fig 3.2: Change in temperature at different level in gunny bag vs ambient storage

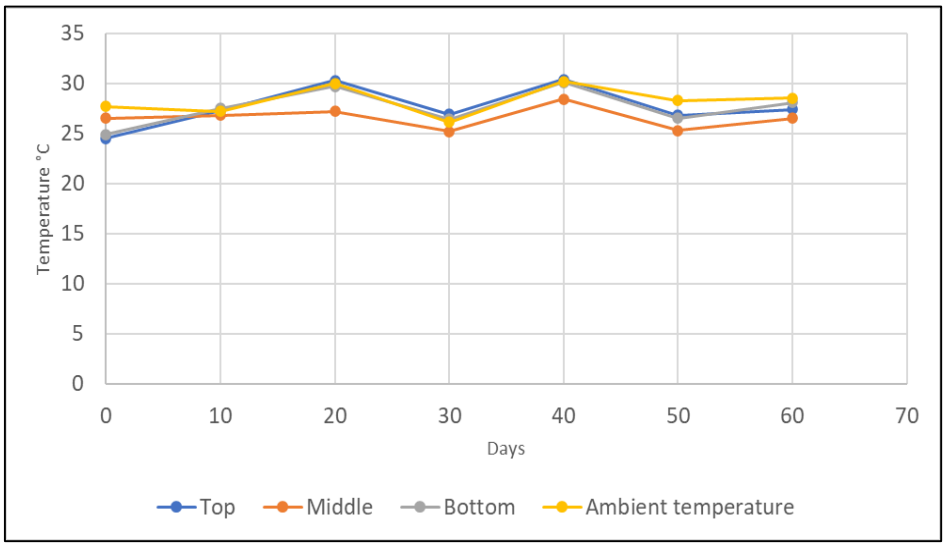

Fig 3.3: Temperature changes at different level in gunny bag vs ambient storage

The maximum temperature recorded in gunny bag storage and ventilated storage were found to be 32.8°C and 30.4°C at 40th day of storage. It was observed that the temperature inside the ventilated bin storage was lower temperature than gunny bag storage. The result showed that the influence of external environment was lower in ventilated bin storage which improves the environment condition to store the groundnut and it also protect from insect, pest, rodents and moulds. Fig 3.2 and 3.3 depicts the change in temperature of ventilated bin and gunny bag storage at three different levels.

Effect of protein content in groundnut in ventilated bin and gunny bag during storage

The change in protein content in ventilated bin and gunny bag storage was shown in fig 3.4. During storage period, the initial protein content of groundnut was about 24.5% which reduced to 23.1% in ventilated storage and 21.5% in gunny bag storage at period of 60 days. Reduction in protein content is due to deamination of protein. The impact of environmental condition was high on the gunny bag storage when compared to ventilated storage, w resulted in decreasing protein content observed by Pushpamma and Rao (1981) [13]. The statistical analysis also showed that there was a significant difference in protein content at the level of $P<0.01$. The protein loss in ventilated storage was found to be 9.05% whereas loss in gunny bag storage was about 15.3%.

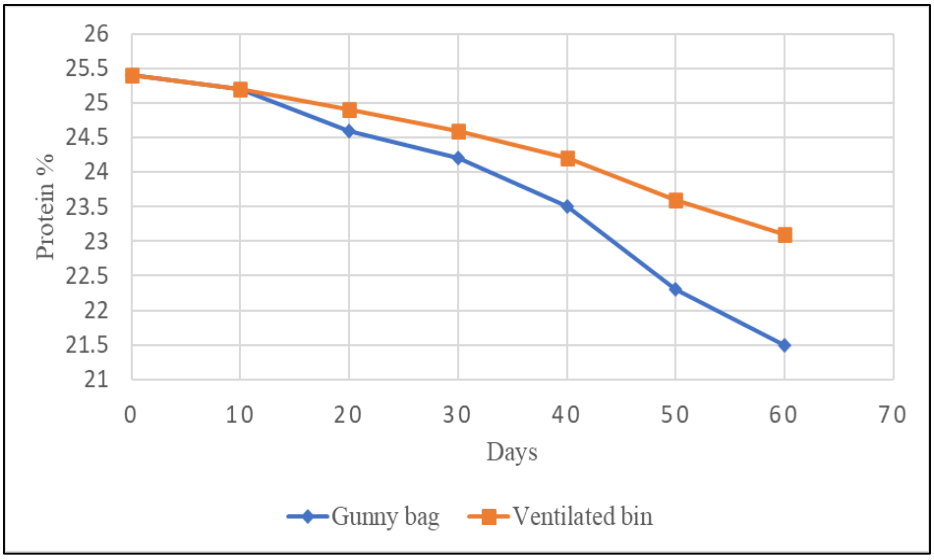

Fig 3.4: Protein percentage of groundnut in gunny bag and ventilated storage

Effect of starch content changes in groundnut in ventilated bin and gunny bag during storage

The change in starch content during storage of groundnut was shown in Fig 3.5. The initial starch content was found to be 11.88%. After 60 days of storage, the starch was reduced to 8.9% and 9.7% in gunnybag storage and Ventilated stored. The loss in starch content might be due to breakdown of sugars reported by (Mali and Vir*et al.*, 2000) [9].

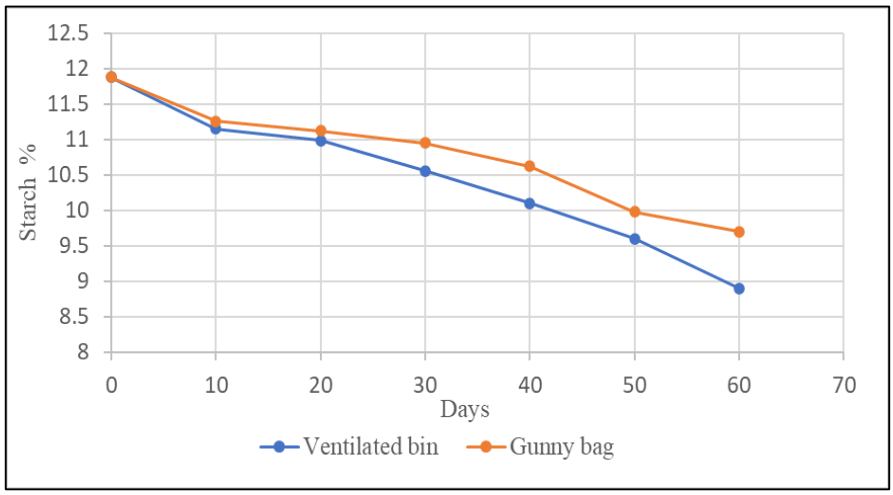

Fig 3.5: Starch percentage of groundnut in gunny bag and ventilated storage

The ventilated storage experienced only 18.35% whereas in gunny bag reported 25.08% losses. The statistical analysis also showed that there was a significant difference in starch content at the level of $P<0.01$.

Effect of oil content in groundnut in ventilated bin and gunny bag during storage

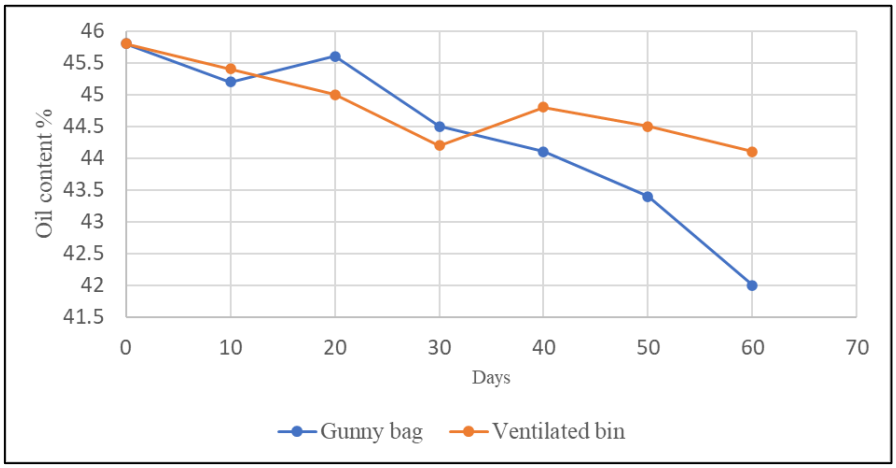

Fig 3.6: Oil percentage of groundnut in gunny bag and ventilated storage

The oil content in groundnut followed a decreasing trend in gunny bag than ventilated storage. Initial oil content was about 45.8% in both the storages where it reduced to 42% in gunny bag storage and 44.1% in ventilated bin storage. The changes in oil content at period of 60 days in both the storage shown in fig 3.6. The reduction in oil content of groundnut was due to oxidation of lipids. (Canavar *et al.*, 2015) [2].

Effect of free fatty acid content of groundnut in ventilated bin and gunny bag during storage

The change in Free Fatty Acid content during storage was observed. The Free Fatty content was increased from 2.78 to 4.2% in gunnybag and 3.3% in Ventilated bin. The Free Fatty acid change was due to hydrolysis of triglycerides and the effect of moisture content during storage in groundnut (Salman and Copeland., 2007) [15]. The change in FFA content during storage of groundnut was shown in Fig 3.7.

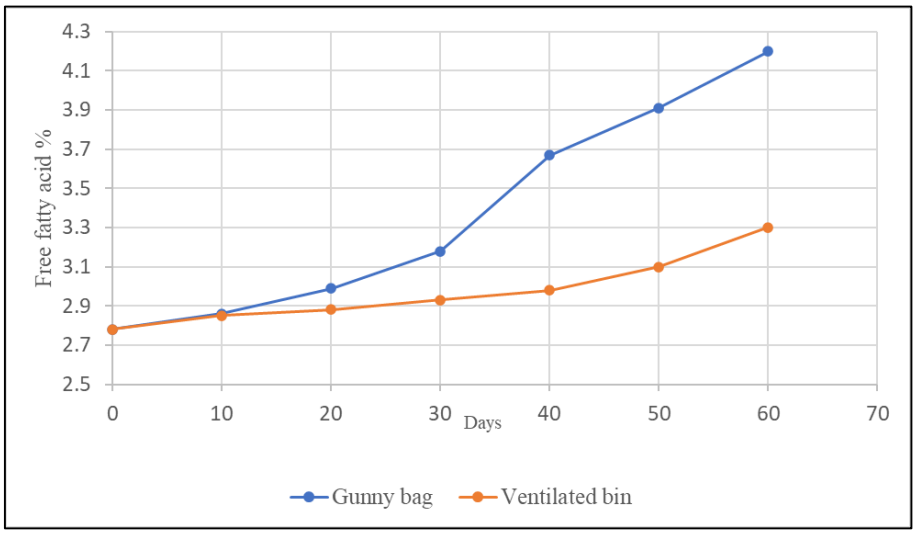

Fig 3.7: Free fatty acids percentage of groundnut in gunny bag and ventilated storage

The statistical analysis also showed that there was a significant difference in FFA content at the level of $P<0.03$

Effect of Peroxide value in groundnut in ventilated bin and gunny bag during storage

Fig 3.8 shows the change in peroxide value in ventilated bin and gunny bag during storage period of 60 days. At the first day of storage, the peroxide value of groundnut was found to be 2.24mEq/kg. In gunnybag storage, the peroxide value follows increasing trend from 2.24 to 5.65mEq/kg. The peroxide value of ventilated storage also increased from 2.24 to 3.98 mEqu/kg.

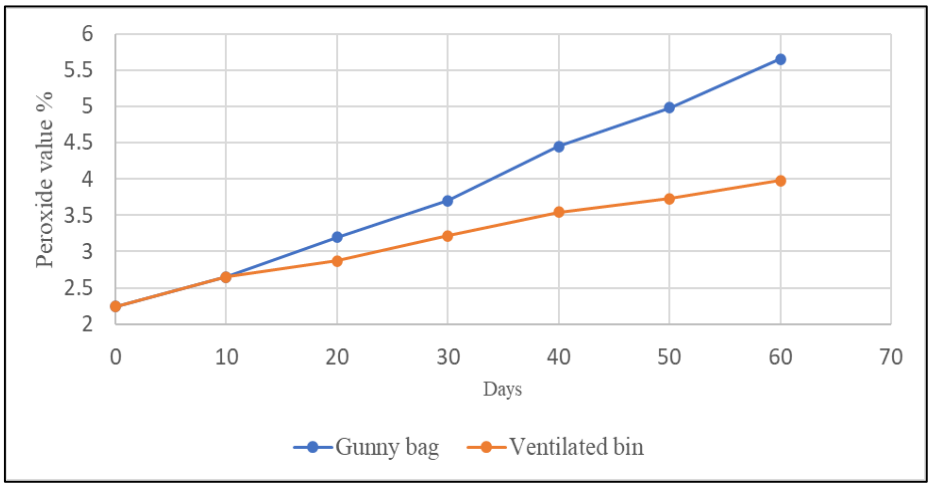

Fig 3.8: Peroxide percentage of groundnut in gunny bag and ventilated storage

Fig 1: Ventilated Storage bin

Fig 2: Gunny bag storage

Conclusion

Due to improper storage, groundnuts are highly impressionable to insects, pest, rodents and moulds and loss

in their biochemical property. To quash the issue, the mild steel bin was fabricated. During the storage period of 60 days, the moisture increase was lesser in ventilated storage about 8.2% while on gunny bag it is found to be 10.5%. The protein, starch and oil content was decreased while on Free fatty acid and peroxide value was increased in both the storage methods. The temperature varied in accordance with the climatic condition. The fabricated bin was efficacious to store the groundnut. Without incorporation of any chemicals, ventilated storage structure was found to be productive.

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