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Water Activity in Treated and Untreated Traditional Grain Storage

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ABSTRACT

The present study was conducted to know the water activity in the behaviour of treated and untreated traditional grain storage. The freshly harvested maize grains (DKC 9082; 12.0% w. b.) were stored under five different types of storage *i.e.,* in Hermetic bags (super bags), Polyethylene bags, Plastic bags and Jute bags, Metal bin and Mud bin with and without treatment at ambient condition (30± 5°c) for study. Out of fifteen, three treatments *viz.,* T_1: Jute bag with Hermetic bag; T_2- Plastic with Hermetic Bag; T_3- Metal bin with Hermetic bags grouped under untreated whereas, twelve treatment *viz.,* T_4- Jute bag with polythene treatment of neem; T_5- Jute bag with treatment of neem, T_6- Plastic bag with Polythene treatment of neem; T_7- Plastic with treatment of neem, T_8- Metal Bin with polythene Bag treatment of neem; T_9- Metal Bin with treatment of neem; T_{10}- Jute bag with polythene treatment of chemical; T_{11}- Jute bag with treatment of chemical; T_{12}- Plastic with polythene treatment of chemical; T_{13}- Plastic bag with treatment of chemical; T_{14}- Metal bin with polythene Bag treatment of chemical and T_{15} Metal Bin with treatment of chemical storage modes were placed under treatment. The variation in temperature and relative humidity were recorded on a daily basis and the physical properties such as grain moisture content, water activity was recorded monthly. The result revealed that the water activity was found as 0.55 during the initial storage days. In untreated group, the values of water activity were observed slightly increased 0.58 in T_1 while T_2 and T_3 showed similar increased values 0.61 and 0.62 as compared to initial values. In neem leave treated storage water activity was T4 in 0.63, while T5 and T_7 similar values were 0. 67, T6 in 0.64, and T_8 in 0.66, the highest value increased were T_9 in 0.69. In chemical treatment, the highest value was 0.70 in T_{15}, while the lowest value was 0.63 in T_{10} at the 6th month of storage period in the different storage mode bag. It was concluded that the untreated group exhibited slightly increased values of the water activity in comparison to values recorded at initial stage but less than treated group.

Key Words: Hermetic, Moisture, Metal bin, Mud bin, Storage, Water activity.

INTRODUCTION

The post-harvest processing technology deals about the processes and treatments run on agricultural produce after harvest for its protection, conservation, processing, packaging, distribution, marketing, and utilization to full fill the food and nutritional need of the people. Therefore, it can be narrated that the post-harvest processing activity included all operations from the beginning of harvest till the material reaches the end-users as per desired form, place, packaging, quantity, quality, as well as price. It has to be developed in congruity as per need of society in view of enhance agricultural yield, prevention of post-harvest

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losses, improvement of nutrition and add value to the products. However, more attention is required during primary processing aspects, in relation with cleaning, grading, drying, storage, and packaging.

The water activity (a_w) of a food is the ratio between the vapour pressure of the food itself, when in a completely undisturbed balance with the surrounding air media, and the vapour pressure of distilled water under identical conditions. A water activity of 0.80 means the vapour pressure is 80 percent of that of pure water Berg and Bruin (1991). The water activity increases with temperature. The moisture condition of a product can be measured as the equilibrium relative humidity (ERH) expressed in percentage or as the water activity expressed as a decimal. Most foods have a water activity above 0.95 and that will provide sufficient moisture to support the growth of bacteria, yeasts, and molds. The amount of available moisture can be reduced to a point which will inhibit the growth of the organisms. If the water activity of food is controlled to 0.85 or less in the finished product, it is not subject to the regulations of 21 CFR Parts 108, 113, and 114. *Monitoring a_w is a critical control point for many foods industry operations* Fontana (2000). The importance of water activity (a_w) in food systems cannot be overemphasized. Throughout history water activity in food has been controlled by drying, addition of sugar or salt and freezing. These methods prevent spoilage and maintain food quality. Water activity is the ratio of the partial vapour pressure of water in equilibrium with a food to the partial saturation vapour pressure of water vapour in air at the same temperature. This is equal to the relative humidity of air in equilibrium with the food. The water activity of a food describes the energy state of water in the food, and hence it's potential to act as a solvent and participate in chemical/biochemical reactions and growth of microorganisms. It is an important property that is used to predict the stability and safety of food with respect to microbial growth, rates of deteriorative reactions and chemical/physical properties Akbar *and* Alam (2019).

MATERIALS AND METHODS

Sample preparation

Fresh and healthy maize and wheat grains were arranged from Borlaug Institute of South Asia BISA, Pusa whereas fumigant like Celphos was procured from the market. Cleaning and grading of grain were done in seed cleaner cum grader machine (gravity separator), Model 2TPS and manufactured by M/s Padsons Pvt. Ltd. Grains coming from the bottom screen were discarded and only top and main grain outlet was used for storage study. The grain is weighted 40 kg on weighing machine and stored in different storage bags.

Moisture Content

The moisture content of sample was determined by standard hot air oven method. The samples were dried in the hot air oven at $102^{o}C \pm 2^{o}C$ for 24hr. The total dry materials or the initial moisture content of sample was determined in accordance with AOAC method (Anonymous, 1990).

Treatments

The experiment consisted of fifteen treatments, using six different types of storage modes with and without fumigants. The treatments were:T_1: Jute bag + Hermetic bag; T_2 :Plastic + Hermetic Bag;T_3: Metal bin + hermetic bags; T_4: Jute bag + polythene + neem treatment; T_5: Jute bag + neem treatment, T_6:Plastic bag + Polythene + neem; T7:Plastic + neem T_8:Metal Bin + polythene Bag + neem; T_9: Metal Bin + neem; T_{10}: Jute bag + polythene + chemical treatment; T_{11}: Jute bag + chemical treatment; T_{12}:Plastic + polythene + chemical treatment; T_{13}:Plastic bag + chemical treatment; T_{14}:Metal bin + polythene Bag +Chemical; T_{15}:Metal Bin + chemical. The containers were placed in a room made of concrete roof and wall with suitable ventilation. All the treatments were kept under ambient conditions. The different treatments were arranged in two rows on a dunnage so as to protect the grains bags from the direct contact with ground.

Table 1. Variation in water activity in different bag storage with untreated and treated conditions.

Storage Treatment	Water Activity					
	Month					
	May-21	June-21	July-21	Aug-21	Sept-21	Oct-21
T_1- Jute bag + Hermetic bag	0.55	0.56	0.56	0.57	0.58	0.58
T_2- Plastic bag + Hermetic Bag	0.55	0.57	0.57	0.58	0.59	0.60
T_3-Metal bin + hermetic bags	0.55	0.57	0.57	0.59	0.60	0.61
T_4- Jute bag + polythene + Neem treat.	0.55	0.57	0.58	0.60	0.61	0.63
T_5- Jute bag + Neem treatment	0.55	0.59	0.62	0.64	0.66	0.67
T_6- Plastic bag + Polythene + neem	0.55	0.58	0.59	0.62	0.63	0.64
T_7- Plastic bag+ Neem	0.55	0.6	0.63	0.65	0.67	0.67
T_8- Metal bin + polythene Bag + Neem	0.55	0.58	0.61	0.63	0.64	0.66
T_9- Metal bin + Neem	0.55	0.61	0.65	0.67	0.68	0.69
T_{10}-Jute bag +Polythene +Chemical treat	0.55	0.57	0.59	0.61	0.62	0.63
T_{11}-Jute bag + Chemical treatment	0.55	0.6	0.63	0.66	0.67	0.68
T_{12}-Plastic + Polythene + Chemical treat	0.55	0.58	0.6	0.62	0.64	0.65
T_{13}-Plastic bag + Chemical treatment	0.55	0.59	0.62	0.64	0.65	0.67
T_{14}-Metal bin +Polythene Bag +Chem	0.55	0.61	0.64	0.67	0.67	0.69
T_{15}- Metal bin + Chemical	0.55	0.62	0.66	0.68	0.69	0.70

The temperature and relative humidity were recorded on a daily basis while the other dependent parameters were recorded on Monthly basis.

Observations

From each bag, grain samples were obtained with a compartmentalized grain sampling spear (Seed buro Equipment Company, Chicago, USA), 10 times at one monthly intervals. The sampling spear was 1 m long, with fives lots, 15 cm long, evenly-spaced, and separated from each other by a 2.5 cm-long wooden plug.

Water Activity

Water activity is defined as the ratio of the vapour pressure of water in a material (p) to the vapour pressure of pure water (p_o) at the same temperature. Water activity (A_w) is one of the most critical factors in determining quality and safety of the goods. It affects the shelf life, safety, texture, flavour, and smell of foods. Water activity may be the most important factor in controlling spoilage. Most bacteria, for example, do not grow at water activities below 0.91. Water activity was measured during experimentation using water activity meter at ambient temperature

RESULTS AND DISCUSSION

Water activity

The water activity of the grain was initially at 0.55 for all untreated maize samples under study. It was recorded highest (0.60) in case of T_2- Plastic bag + Hermetic Bag and T_3-Metal bin + hermetic bags while lowest (0.61) for untreated maize contained in jute bag with super grain bag stored period at room temperature in 0 to 6 m. The water activity increased to 0.61 in the jute bag with super grain bag, 0.62 for untreated maize jute bag with polythene bag storage and same metal bin with hermetic bags untreated when stored at room temperature.

In case of treated (Neem) samples stored in T_4- Jute bag + polythene + Neem treatment, T_5- Jute bag + Neem treatment, T_6- Plastic bag + Polythene

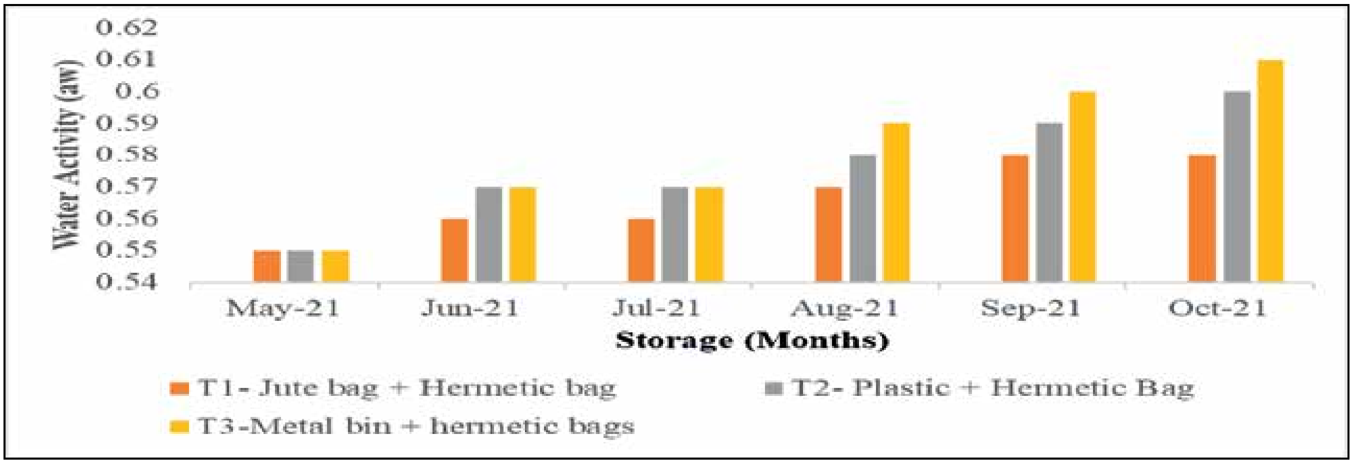

Fig 1. Variation of water activity of untreated maize samples during storage.

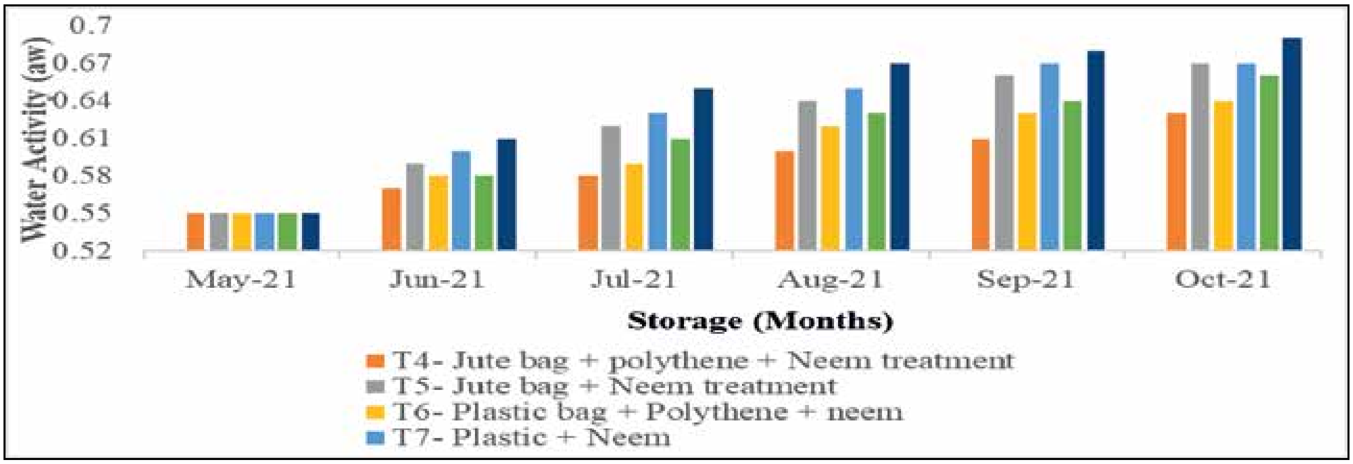

Fig 2. Variation of water activity of treated (Neem) maize samples during storage.

+ neem, T_7- Plastic bag+ Neem, T_8- Metal bin + polythene Bag + Neem, T_9- Metal bin + Neem, the highest water activity value was seen to be 0.69 for T_9 while the lowest water activity was 0.63 in T_4 when stored period at room temperature in 0 to 6 months.

In case of treated (Chemical) samples stored in T_{10}-Jute bag +Polythene +Chemical treatment, T_{11}-Jute bag + Chemical treatment, T_{12}-Plastic + Polythene + Chemical treatment, T_{13}-Plastic bag + Chemical treatment, T_{14}-Metal bin +Polythene Bag +Chemical, T_{15}- Metal bin + Chemical, the highest water activity value was seen to be 0.70 for $T_{15,}$ while the lowest water activity was 0.63 in T_{10} when stored at room temperature in 0 to 6 months.

The lowering of water activity with storage period may due to increase in moisture content owe due to increased respiration rate and due to variation in relative humidity during storage period. The present findings were in accordance with findings of Akbar and Alam (2019) and Torresa *et al* (2003).

The water activity of maize grain storage for treatments T_1, T_2, T_3, T_4, T_{10}, T_6, T_{12}, T_8, T_{13}, T_5, T_7, T_{11}, T_{14}, T_9, and T_{15} were found to be in increasing order of untreated and treated (chemicals and Neem leaves). Water activity in Maize storage for all 15 treatments, untreated and treated, was found to be Significant for all data from the time of storage to last 12 months.

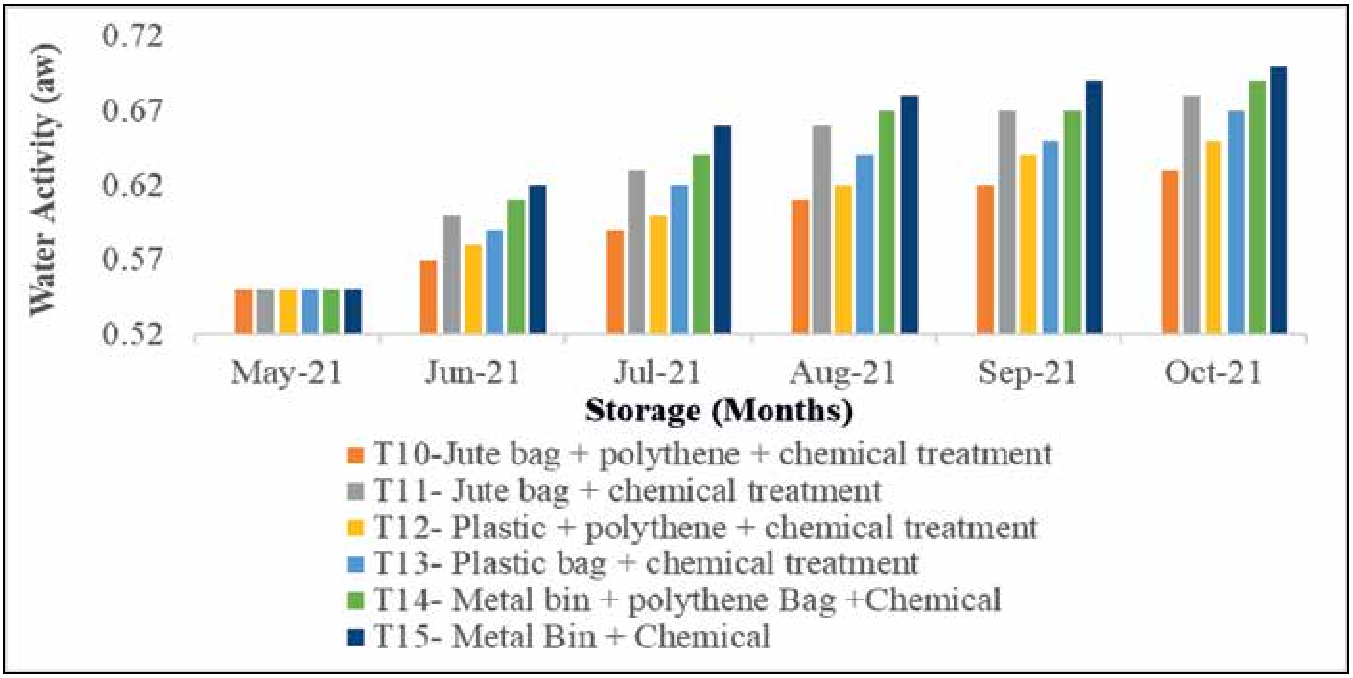

Fig 3. Variation of water activity of treated (Chemical) maize samples during storage.

The lowering of water activity with storage period may be due to increase in moisture content owing due to increased respiration rate and due to variation in relative humidity during storage period. It was found similar result that super grain bags had the lowest variance in maize water activity (0.132), while chemically untreated jute bags had the highest variation (0.166). The metabolism of insects and microorganisms in the oxygen-depleted and carbon dioxide-rich inter-granular habitats of the storage ecosystem accounts for the lowest change in the moisture content in tightly sealed storage bags as stated, Kumari *et al* (2017). However, due to the permeability of polypropylene bags, grains lost moisture in response to the relative humidity of the surrounding air. Water, temperature, and air are a few elements that affect insect infestation in the ecosystem of grain storage (Marin 1998), and as a result, insect damage rises during storage.

The present results are fairly in line with findings of Marin *et al* (1999) and Suhr and Nielsen (2004). They demonstrated that sufficient availability of water enhanced the total fungal population of stored maize grains. In other studies, conducted by Beg *et al* (2006), Zinedine *et al* (2007) on broiler feed having maize grains as vital ingredient reported that fungal colonization and ultimately mycotoxins accumulation was a serious issue that was affected by various factors including water availability and length of storage time. Reasonably warm and humid climatic environment, poor post-harvest management and insufficient storage practices facilitate the fungal growth and mycotoxins production (Hell *et al,* 2000; Klich, 2007). There are several methods which can be used for the control of fungal growth in cereals e.g., thermal inactivation, irradiation, enzymatic and microbial degradation, use of chemical preservatives and reducing the water activity of the substrate (Byun and Yoon, 2003; Haque *et al,* 2009; Alam *et al,* 2009).

CONCLUSION

The result revealed that the water activity was found very well as 0.55 during the initial storage days. In untreated group, the values of water activity were observed slightly increased to 0.58 in T_1 while T_2 and T_3 showed similar increased values

0.60 and 0.61 as compared to initial values. In neem leave treated storage water activity was T4 in 0.63, while T5 and T_7 similar values were 0. 67, T6 in 0.64, and T_8 in 0.66, the highest value increased were T_9 in 0.69. In chemical treatment, the highest value was 0.70 in T_{15}, while the lowest value was 0.63 in T_{10} at the 6th month of storage period in the different storage mode bag. It was concluded that the untreated group exhibit slightly increased values of the water activity in comparison to values recorded at initial stage but less than treated group.

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