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Effect of Vacuum Condition on Stored Bengal gram and Gram dhal in Glass bottles and Laminated LDPE Bags

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ABSTRACT: The effect of vacuum on the parameters *viz* moisture content, rehydration capacity and protein content of insect infested bengal gram and gram dhal samples that were stored in glass bottles and laminated LDPE bags, was studied. Vacuum was created in glass bottles with low cost gas filling device which was developed in JNKVV Jabalpur and in laminated LDPE bags vacuum sealing machine was used. The samples were packed with five insects of *Callosobruchus chinensis* in Bengal gram and *Rhizopertha* in gram dal under vacuum for 120 days. The effect of vacuum on the parameters of bengal gram and dhal were analysed on every 30 days interval. At each interval of storage, the significant differences were observed an increase in moisture content, rehydration capacity and decrease in protein content in respective packaging materials. The observation found that moisture content increased with 8.467% and 8.367% for bengal gram, 9.567% and 9.433% for gram dhal on wet basis in laminated LDPE bags and glass bottles respectively. Similarly rehydration capacity of bengal gram and gram dhal increased with 0.237 g/g and 0.245 g/g, 0.079 g/g and 0.08 g/g in laminated LDPE bags and glass bottles respectively. Protein content for bengal gram decreased from 19.65% to 18.001% in laminated LDPE bags and 19.65% to 18.487% in glass bottles. Whereas protein content for gram dhal decreased from 17% to 14.925% in laminated LDPE bags and from 17% to 15.625% in glass bottles. Storage condition under vacuum in glass bottles for bengal gram and gram dhal gave the best results than laminated LDPE bags.

KEYWORDS: Bengal Gram, Gram Dhal, Vacuum, Storage, Glass bottles and laminated LDPE bags

I. INTRODUCTION

Pulses play vital role in healthy diet to achieve better health in developing countries, for suitable food production and food security. These are rich in protein, carbohydrates, fiber, micronutrients and vitamins, lower in fat and low sulfur containing amino acids which are very helpful to recover the protein malnutrition among vegetarian people. Pulses contain twice the amount of protein found in whole wheat, oat and barley and three times of rice, FAO (2016). Bengal gram (*Cicer aritinum L.*), locally named as *Kala Chana* is the third most important pulse crop after dry bean and peas produced in the world contains 17-20% of protein (<http://www.aicrpchickpea.res.in>). Per 100g of bengal gram contains 21.2g protein, 5.4 g fat, 12.4 g fiber, 45.5 g carbohydrate, zero g cholesterol and remaining portion of micro-nutrients (FAO, 2016). Due to low glycemic index, it is more suitable for diabetic patients. It is used to make gram dhal (*Chana Dhal*), which is split bengal gram with the skin removed, FAO (2016).

Pulses are more difficult to store than cereal and prone to suffer much higher damage from external living organisms like insects, rodent and microorganism. Due to this reason, qualitative as well as quantitative losses of nutritional values of pulses because of protein quality occur (Rajiv Ratan Lal, et.al. 2007). Though, pulses have high protein content, prone to very high insect infestation and thus undergo heavy losses during storage. The stability as well as viability of pulses should be preserved by high-quality scientific storage methods.

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Satisfactory and efficient storage of pulses can be achieved with proper and suitable packaging materials such as glass containers or polyethylene bags by using suitable scientific packaging techniques such as hermetic storage, vacuum and modified atmosphere storage, mix storage, fumigation etc. to check the deterioration, protects the quality of grain and help to stabilize the economy. It helps to supply of grain over the period of time.

In modified atmosphere storage, stored seeds can be disinfested by an alteration of the natural storage gases such as carbon dioxide, oxygen and nitrogen to create the lethal atmosphere to pests. While low atmospheric or negative pressure can be created by drawing out the air from the pack prior to the final sealing in vacuum packaging, to obtain insect kill within reasonable periods, it gives the significant effect on insect mortality, Navarro (2006). Meena M.K. *et. al.* (2017) found that vacuum storage increases the shelf life of food grains by inhibiting the growth of microorganisms and improves hygiene by reducing the danger of cross contamination. Vacuum hermetic storage was very effective in prevention and disinfestations of infested stored food grains in less exposure time for complete mortality of insects in comparison to phosphine fumigation for same quantity, proved by Kumar S. *et.al.*, 2016. Sanjeev K. *et.al.* (2006) and Meena M.K. *et. al.* (2017) claimed that vacuum packaging and gas flushing techniques are used for the purpose to extend the shelf life and prevention of food spoilage by oxidation. Hence, the objectives of this study were to investigate the effect of vacuum on the samples of bengal gram and gram dhal stored in glass bottles and laminated LDPE bags.

II. MATERIALS AND METHODS

The samples of Bengal gram and gram dhal were procured from local market of Jabalpur, Madhya Pradesh. Samples in three replications were stored in glass bottles and laminated LDPE bags under vacuum for 120 days to analysed the behavior of vacuum on the parameters such as moisture content (%wb), rehydration capacity and protein content. Five insects named *Callosobruchus chinensis*, (Modgil R. *et. al.*1997and Chandel B.S. *et al.* 2015) were released in Bengal gram samples and *Rhizopertha* in gram dhal (Rajiv Ratan Lal *et.al.* 2007). Each sample was unpacked to estimate the supposed parameters for every 30 days regular interval. Vacuum is created by vacuum sealing machine inside the laminated LDPE bags and to create vacuum in glass bottles by low cost gas filling device which was designed and developed in JNKVV Jabalpur through a special valve and pipe system connected to vacuum pump.

2.1. Moisture Content

Moisture content of grain samples was determined by method i.e. using OSAW digital type Universal Moisture Meter (Chandel B.S. 2015).

2.2. Rehydration Capacity

The rehydration capacity of grain samples were determined by using the procedure, which was adopted by Shimelis (2006) and Oluwatosin *et.al.* (2016). 20 g samples of Bengal gram and gram dhal were soaked in distilled water for 12hr. at ambient room temperature. Then water was drained out and samples were placed on filter paper to remove free surface water, and then weighed. Rehydration capacity was determined by following formula-

$$\text{Rehydration capacity} = \frac{\text{Weight of soaked grain} - \text{Weight of unsoaked grain}}{\text{Weight of Sample}}$$

2.3. Protein Percentage

Micro-kjeldahl Digestion and Distillation Procedure as given by AOAC (1965) was used to determine the Protein percentage of samples of Bengal gram and gram dhal by following formula-

$$\text{protein \%} = \frac{\text{Normality of H}_2\text{SO}_4 \times \text{Titrated value} \times 14 \times 6.25 \times 100}{\text{Weight of Sample} \times 1000}$$

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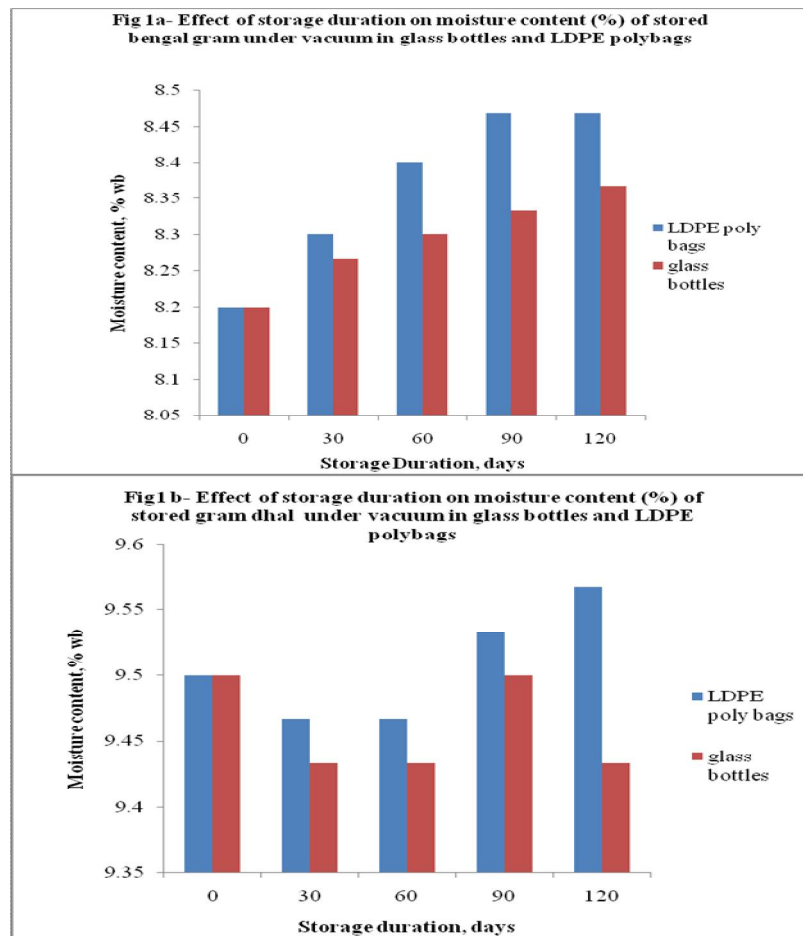
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III. RESULTS AND DISCUSSION

In this study the variations in parameters with respect to packaging materials viz: glass bottles and laminated LDPE bags were noted.

3.1. Effect of storage period on moisture content of bengal gram and gram dhal under vacuum condition

The moisture content of stored Bengal gram and gram dhal increased with storage duration under vacuum. At the end of the 120 days, the increment in moisture content of Bengal gram was found in laminated LDPE bags was 8.467% and 8.367 % in glass bottles (Fig- 1a). While for gram dhal, it was 9.567% and 9.433% in laminated LDPE bags and glass bottles respectively (Fig-1b). This is due to barrier properties of packaging materials. Glass containers are impermeable to the passage of gas and water vapour *Food Processing: Principles and Applications* (2014) while laminated LDPE bags are permeable to gas and water vapours. The result showed that minimum increment in moisture content in glass bottles than laminated LDPE bags.



3.2. Effect of storage period on rehydration capacity of bengal gram and gram dhal under vacuum condition

The rehydration capacity of stored samples under vacuum increased with storage duration. The rehydration capacity of bengal gram was increased from 0.21 g/g to 0.237 g/g in laminated LDPE bags and 0.245 g/g in glass bottles (Fig-

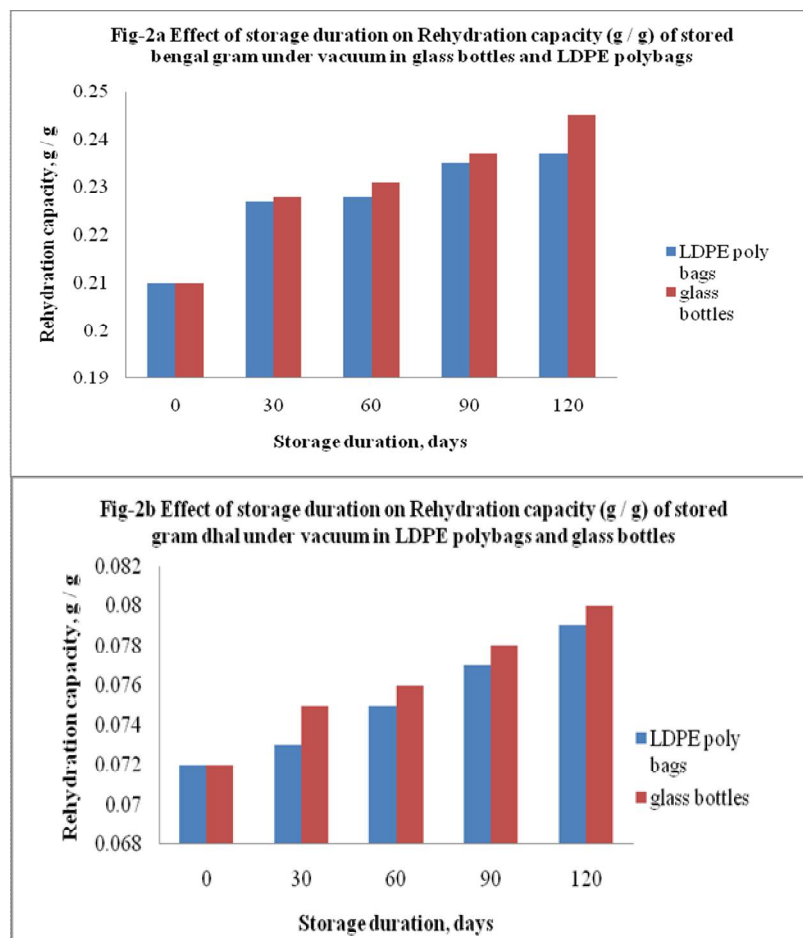
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2a). While for gram dhal, increment was found from 0.072 g/g to 0.079 g/g and 0.08 g/g in laminated LDPE bags and glass bottles respectively (Fig-2b). This is due to barrier properties of packaging materials. The result showed that glass bottles have minimum increment in rehydration capacity than laminated LDPE bags.



3.3. Effect of storage period on protein content of Bengal gram and gram dhal under vacuum condition

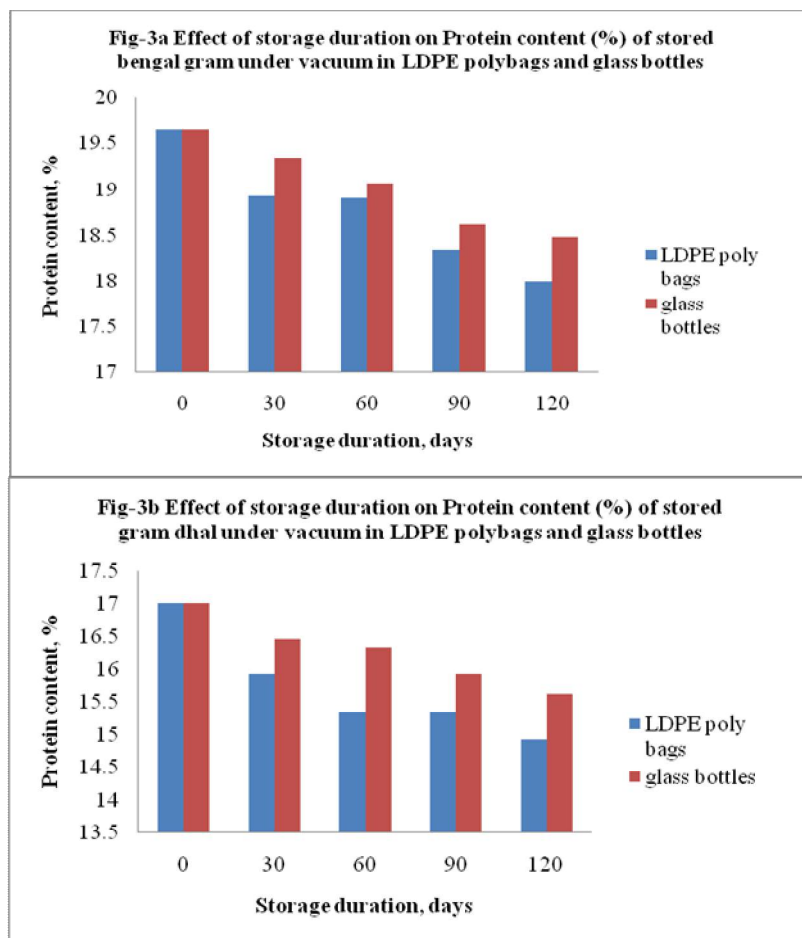
It was observed that the loss in protein content of samples stored under vacuum was decreased with storage duration. The observations found that the protein content of bengal gram was decreased from 19.65% to 18.001% in laminated LDPE bags and 18.487% in glass bottles (Fig- 3a) and for gram dhal, it was decreased from 17% to 14.925% and 15.625% in laminated LDPE bags and glass bottles respectively (Fig-3b). The result showed that glass bottles have minimum increment in rehydration capacity than laminated LDPE bags. As an increase in moisture content of the samples retained in laminated LDPE bags, shows in section 3.1, protein chains form loose mesh. This may be responsible for protein loss. Similar trend was also found by Deepa G.T. *et al.* (2013) for chili seeds stored under vacuum.

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IV. CONCLUSIONS

In this study, effect of vacuum on moisture content, rehydration capacity and protein content of stored bengal gram and gram dhal for 120 days under vacuum in glass bottles and laminated LDPE bags were investigated. It was found that increase in moisture content and rehydration capacity was lesser in glass bottles than laminated LDPE bags. While loss in protein content has been found lower in glass bottles as compared to laminated LDPE bags. Therefore glass bottles were found as a good packaging material in comparison to laminated LDPE bags to store bengal gram and gram dhal under vacuum.

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