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Can Grain Be Disinfested In 5-Gal HDPE Buckets Containing Oxygen Absorber Packets?

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Grain disinfestation with O_2 abs…

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ABSTRACT:
Effective methods of grain disinfestation include freezing, the use of carbon dioxide gas, and the use of pesticides. Oxygen deprivation has also been shown to be an effective method of disinfestation when the oxygen content is held below 1% for at least 12 days (d). High Density Polyethylene (HDPE) 5 gallon (gal) buckets have become a popular and convenient storage container for dry foods such as wheat, rice and beans. Oxygen absorber packets are an effective way to remove the oxygen in high-barrier sealed containers to prolong the life of many of these foods. It is hypothesized that sealed HDPE buckets containing oxygen absorber packets can be used to reduce the oxygen to low enough levels for enough time to accomplish disinfestation. Experiments were conducted to determine how long the oxygen content of 5 gal buckets filled with wheat could be held below 1% when various numbers of oxygen absorber packets were packaged with the wheat. Although it was possible to use oxygen absorbers to reduce the oxygen level below 1% for 12 d, this treatment was shown to be an unreliable disinfesting method because the oxygen levels in the samples exceed 1% too frequently. Because this method is inconsistent consumers would require evidence that the necessary conditions have been met, but this would call for tools not available to most consumers. Therefore, it is not recommended that consumers use this method to disinfest grains.

Keywords: Grain Disinfestation, Oxygen Deprivation, HDPE buckets

Practical Application:
Oxygen absorber packets are not a practical method for the disinfestation of grain, especially for consumers using them for long term food storage purposes.

Introduction

The use of pesticides or freezing as well as the use of nitrogen (N_2) flushing, carbon dioxide (CO_2) flushing, oxygen (O_2) absorber packets, and other forms of atmosphere modifications have been shown to be effective in the long term protection of grains stored in properly sealed cans (Gilberg and Roach 1993). Disinfestation methods that have been proven to be effective for stored grain include carbon dioxide (Banks 1979, Banks and Sharp 1979), freezing (Fields 1992, Houseman 2006), and pesticides (Harein and Subramanyam 1990). Oxygen deprivation has also proven to be an effective means of disinfestation. Studies performed by Storey (1973, 1975, 1978) showed complete

elimination of weevil, moths and confused flour beetles after 8, 5, and 4 days respectively when oxygen levels were maintained below 1%. Other studies performed by Tarr and Clingeleffer (2005) and Gilberg and Roach (1993) showed that an O_2 level maintained below 1% for 12 d was sufficient to completely kill the Saw-tooth Grain Beetle. Since oxygen deprivation can be accomplished by placing oxygen absorber packets in high-barrier sealed containers, it is a convenient disinfestation method for home storage of dry goods. Number 10 steel cans have proven to be an effective and reliable high-barrier container. Polyethylene terephthalate (PETE) has also proven to be an effective container to be used with oxygen absorber packets for disinfestation (Broderick and others 2010). High-density polyethylene (HDPE) 5 gal buckets have become popular storage containers for dry foods. It is important to know if oxygen levels can be reduced low enough for a time period long enough to disinfest these containers. The most convenient method of producing a low oxygen environment in these containers is to seal oxygen absorber packets with the dry food.

Materials and Methods

Ten HDPE 5 gal buckets were prepared with sampling ports. These ports consisted of a syringe needle (BD Luer-Lok Tip) passed through two stick-on septa on either side of the wall of the bucket within 2 cm of the top. In preliminary experiments, the position of the port did not affect the result (data not shown). A gas tight valve (VICI Precision Sampling Mininert™ valves, Houston Texas) was then attached to the needle and wrapped in teflon tape. The needle was bound to the septa using silicon rubber glue (Dow Corning 732 Multipurpose Sealant).

Ageless ZPT-300 MBC1500 ml O_2 absorber packets were used to consume the oxygen (Mitsubishi Gas Chemical America, Inc., New York, NY) . Each packet was rated to absorb 300 cubic centimeters (cc) of O_2. These packets do not contain moisture, but are activated by the moisture from the stored grain. In preliminary experiments (data not shown), it was determined that a 5-gal bucket filled to 90% capacity with wheat contains approximately 9050 cc of air, of which 1900 cc is oxygen. Seven packets should have more than enough capacity to absorb all the O_2 in a 5-gal bucket filled with wheat.

Buckets were 88-92% filled by volume with hard red winter wheat. A variable number of fresh O_2 absorber packets were placed in approximately the middle of the wheat and the buckets were sealed with HDPE Gamma-Seal lids with rubber gaskets (Bay Tec Containers, Bacliff TX). Treatments included duplicate buckets containing 8, 11, 14, or 17 packets each. The theoretical O_2 absorbing capacity was 2400 cc for 8 packets and 5100 cc for 14 packets. The excess capacity was intended to absorb O_2 that permeated through the HDPE bucket wall and through any imperfect seals. It was expected that the partial vacuum caused by the absorption of the O_2 would encourage infiltration of O_2. The experiment was designed to determine how much O_2 absorbing capacity would be needed to maintain the oxygen level at <1% for 12 d, the time required to accomplish disinfestation.

Prior to sampling, the port was flushed by drawing a full syringe of the internal gas and re introducing it to the system. A 30 cc sample was then drawn from the port using a

syringe with Luer-Lok® tip. The samples were analyzed using the Illinois Instruments 6500 headspace oxygen analyzer in three 10 cc increments. The analyzer was allowed to analyze each 10 cc sample for 60 s before introduction of the next 10 cc sample. The first sample was used to flush the analyzer and was not included in the reported data. The second and third results were averaged to give the reported mean.

Results and Discussion

Measurements were taken for two and a half weeks on days 1, 5, 9, 13, and 17. The results for the control stayed near the expected 20.9% oxygen content. The O_2 content of the buckets containing oxygen absorbing packets is shown in Table 1.

Table 1. O_2 content over 17 d in 5-gal HDPE buckets filled with wheat and sealed with the indicated number of oxygen absorbing packets.

	Oxygen (%)							
	Number of Oxygen Absorber Packets per Bucket							
	8		11		14		17	
Day	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
1	**1.13***	**1.60***	0.72	0.77	0.33	0.42	0.52	0.02
5	0.95	0.66	0.55	0.56	0.53	0.13	0.27	0.00
9	0.50	**1.39***	**2.37***	0.00	0.02	0.01	**1.39***	0.00
13	**1.79***	**5.36***	**7.34***	**1.44***	0.05	0.70	0.08	0.00
17	**2.32***	**8.42***	**10.90***	0.05	0.00	**2.26***	0.76	0.00

* indicates those O_2 contents that exceed the 1% target reported to be necessary to accomplish disinfestation.

The O_2 levels in the buckets over time were inconsistent; the levels in some of the containers held below 1% for the full period of the experiment and others rose above 1% by day 9. It is evident that considerable O_2 infiltrated the buckets. Those buckets containing 8 packets with a capacity to absorb more O_2 than was sealed in the bucket both failed by day 9. Failure of buckets containing even more packets was sporadic and inconsistent. If permeation through the HDPE were the only means of O_2 infiltration, the results of duplicate buckets would have been consistent. The failure of one bucket in each replicate indicates that the seals were imperfect. A second experiment was carried out with less expensive gasketed lids with even a higher rate of failure (data not shown).

Conclusion

These results indicate that it is possible to reduce the O_2 level to < 1% and hold it for 12 d to accomplish disinfestation. It would require the use of 11 or more O_2 absorber packets in each bucket. However, the frequency of failure was unacceptably high. It would be difficult for a consumer to know if conditions required for disinfestations had been achieved because of the unpredictability of the seals. Therefore, it is not recommend that consumers use O_2 absorbing packets in 5-gal HDPE buckets to disinfest wheat or other grains. For the same reasons it is not recommended to store products sensitive to

oxidation in 5-gal HDPE buckets unless the product is to be used before oxidative degradation occurs.

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