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LIPID DEGRADATION OF CORN PRESERVED IN OXYGEN DEPLETED MINIENVIRONMENT

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ABSTRACT

The Corn of 13 % moisture content was preserved in air oxygen depleted minienvironment, with oxygen concentration of 15%, 10%, 5% and <2%.The control sample was preserved innatural atmosphere at 20.9 % oxygen concentration. The main nutrient content of maize, such as starch, protein and lipid, were analyzed periodically at 0, 3, 6, 9 and 12 months during the preservation. The result on degradation of starch and protein has been represented previously. This article introduces the research results on the lipid degradation. The obtained results showed that corn lipid degradation was dependent mainly on the oxygen concentration and storage time. However, after 12 months storage at <2% oxygen concentration the degradation rate of maize grain lipid was very small. In comparison, this degradation rate is lower many times than that at higher oxygen concentration of 10 % and 15%, especially of 20.9 % in the natural atmosphere. The storage efficiency after 12 months preserved at 2 % oxygen atmosphere reached more than 97%.

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INTRODUCTION

Corn is one of the 3most important cereals both for human and animal consumption. In addition maize is also an industrial raw material. Maize contains about 4 to 5% lipids, 85% of which are present in seed germs (Reiners, 1978 and Uddin, 2007). Lipit is one of the main nutritional components of corn, largely used, even for industry (Reiners, 1978; LIST, 1984 and FOS, 1983). Triglycerides and free fatty acids make up more than 80% of the lipids in maize (Mathieu Gayral, 2015). This component is mainly found in the nucleus (Reiners, 1978; LIST, 1984 and FOS, 1983), which plays an important role in seed germination. In addition to its role in the growth of grain, food, livestock, there are many other uses, such as in the pharmaceutical industry, plastics, lubricants…. However, most of the oil produced is purified for direct consumption and used for the food industry (Abdulkadir, 2011). Corn lipid has antioxidant effect, is beneficial for health (Abdulkadir, 2011 and Erickson, 2006). The lipid composition plays an important role for both the seed quality and human nutrition.

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The seasonal factor strongly affects the processing of corn, thus maize preservation is becoming increasingly significant. The preservation using chemical drugs actually causes an environmental pollution and seriouslyimpacts on human health. Today, people are more concerned with environmentally friendly preservation methods, safety and nutritional quality and prolonged shelf life (Le XuanQue, 2011). Alternative methods of preserving toxic chemicals by regulating air composition in storage equipment have been studied extensively in recent years (Ali Akbar Moghadamnia, 2012). Oxygen depleted preservation with dual effect of antioxidant and insecticide potential, has been selected for preservation of maize, seeds and other dry foodstuffs (Le XuanQue, 2011; Le QuocKhanh, 2017; Le XuanQue, 2015). However, the impact of oxygen concentration in preservation minienvironment to corn nutritional degradation, in which the lipid content, has not been evaluated so far. In previous studies, the obtained results on degradation of two major nutrient components, starch and protein, of grain corn preserved up to 12 months in microenvironment with an oxygen concentration of <2% to 20.9%, were represented previously (Le QuocKhanh, 2018 and Le QuocKhanh, 2018). This article presents the results of the study on lipid degradability in similar preservation.

EXPERIMENT

Experimental method for the corn preservation in oxygen depleted minienvironment and determination of corn lipid degradation was conducted in the same way as previously reported (Le QuocKhanh, 2018 and Le QuocKhanh, 2018).

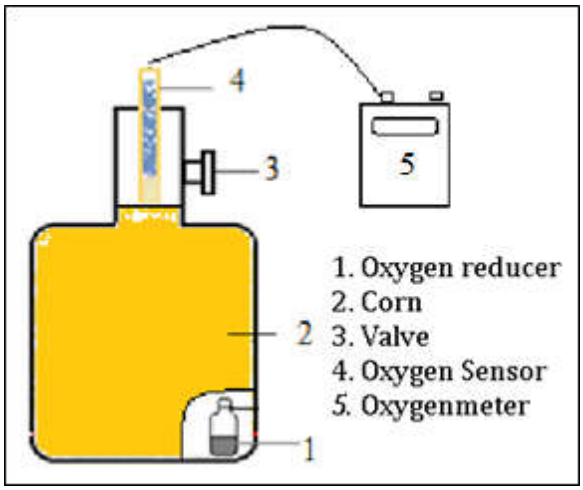

Fig. 1. Schema of preservation mini environment

Samples of maize were preserved at low oxygen concentrations:< 2 % and at 5 – 20,9% (Le QuocKhanh, 2018 and Le QuocKhanh, 2018), sample for lipid content analysis were collected at preservation time of 3, 6, 9 and 12 months. Lipid was determined according to National Standard

RESULTS AND DISCUSSION

The initial content of the measured corn lipid m_0, which was 3.74 g ± 0.03 in 100 g of corn grain, is the value at time t = 0. Thelipid content decreases with preservation time, Figure 1, and inversely with the oxygen concentration in the preservation field, Figure 2.

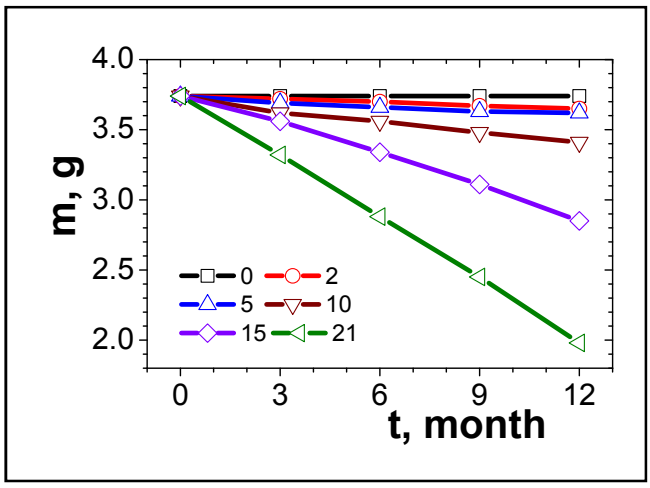

Fig. 1. Variation of lipid content (m) (in 100g of maize) over preservation time in minienvironment with different oxygen concentration C (shown in figure)

It is obvious that the lipid content decreases sharply with the preservation time at oxygen concentration of C> 10%. It can be seen that this decrease at high oxygen concentrations is relatively linear with respect to t. However, the effect of low oxygen concentration on the reduction of initial lipid content is relatively weak, but with a high concentration of C ≥ 10% it isrelatively strong, inversely according to oxygen concentration, Figure 2. However this decrease seems to be exponential, the longer the preservation time, the more obviously.

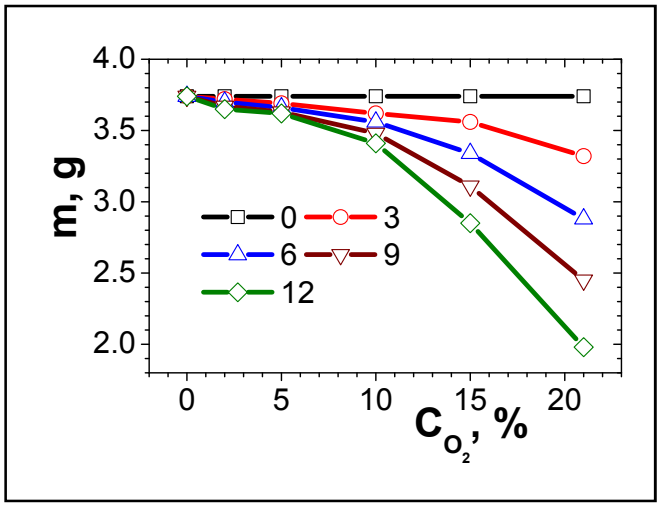

Fig. 2. Lipid content decrease by oxygen concentration in the minienvironment, at 0 - 12 months storage (shown in figure)

To clarify the effect of oxygen concentrations, the variation rate of lipid degradation v has been considered as a function of oxygen concentration (unit g/%), is represented in Figure 3, meanwhile the variation rate v as a function of storage time (unit g/month), is represented in Figure 4.

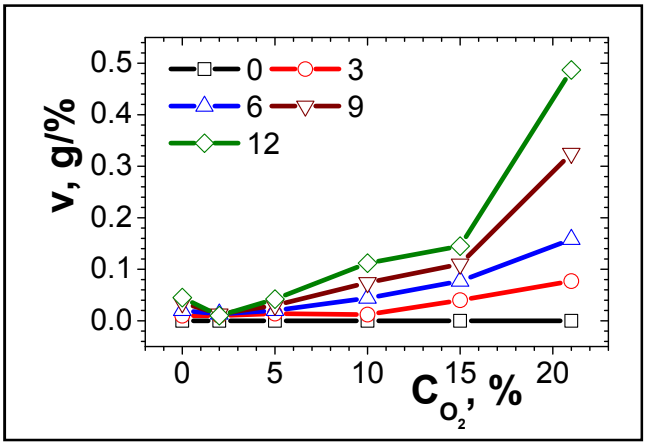

Fig. 3. Variation of lipid degradation rate (v, g/%) as a function of oxygen concentration, at 0-12 months storage (shown in figure)

The graph shows that the oxygen has accelerated the lipid degradation, and that manifests an increasing v (g/%) at all times of 3 to 12 months. However, even at the highest oxygen level, the lipid degradation rates over time v (g/month) are almost stable, Figure 4. That means the preservation time does not accelerate the lipid degradation, in this case, and it is completely different to oxygen impact.

The decrease in lipid degradation rate over time v (g/month) at 5 % and 2 % oxygen concentration, curve 2 and 5 Figure 4, shows that the quality of corn was still ensured perfectly for long time preservation. However at 20.9 % oxygen concentrations an appearance of mold has been observed after 2 months preservation. The amount of mold has been gradually increased over time in the following months. Note that from

10th day of preservation, the number of beetles has increased gradually. At 15 % oxygen concentration mold appeared after 4 months of preservation, but little and only increased slightly in the following months. However Sitophiluszeamais (Motsch) also appeared after 20 days of preservation and quantitatively increased rapidly.

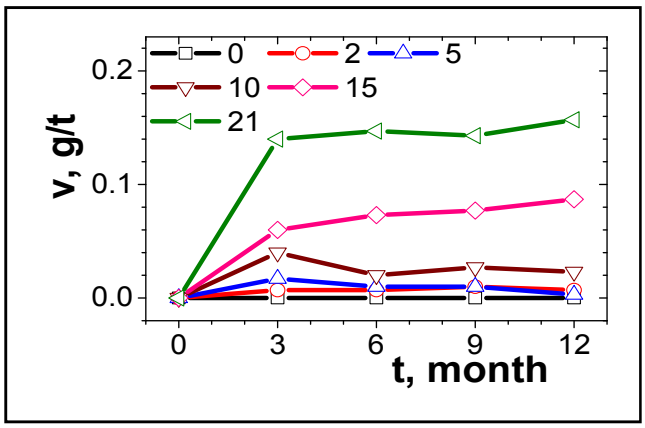

Figure 4. Variation of lipid degradation rate (v) as a function of preservation time (t), oxygen concentration is shown in Figure

It can be seen that in two minienvironments at 20.9% and 15% oxygen level, being considered as of high oxygen levels, there was an intensive respiration of the corn grain, also mold and motsch, causing consequently aquality degradation of preserved corn, in a faster and more powerful way. In comparison with preservation time impact, these living biological factors have a definitely stronger impact on the lipid degradation.At10% oxygen concentration, after appearance, the molds and number of motsch decreased significantly during the first 3 months, then decreased gradually for following months that. This phenomenon has been probably caused by a diminishing reproduction. In the two mediums at low oxygen concentration, of 2% and 5%, there did not appear any mold and motsch during following preservation months.

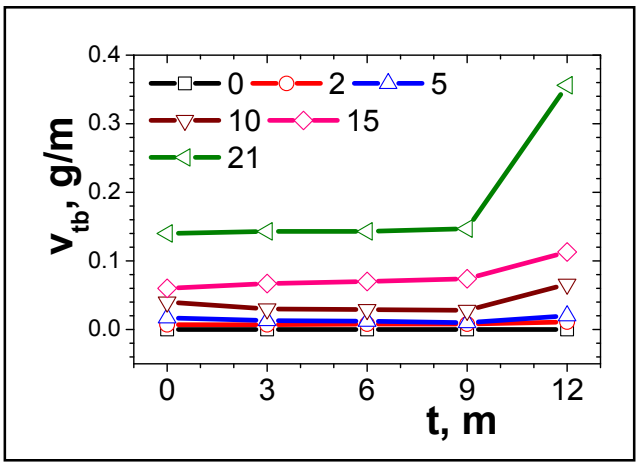

Fig. 5.Variation of average rate of lipid degradation v_{tb} (g/month) at different oxygen concentrations (shown in Figure)

However, if using the mean rate v_m, calculated by the formula $v_m = (m_{i+1} – m_0) / (xi – x_0)$ where m is the lipid content, x is the variation of preservation parameters (time t (month) or oxygen concentration C (%)), i is the sampling point, one can construct graphsv_m – t or v_m – C, in order to clarify the effect of storage conditions. If x is the preservation time t, the v_m graph can be set to t according to formulav_m= $(m_i-m_0)/(t-0)$ (Figure 5). It is easy to see that the value of v_m fluctuates very little, nearly constant during first 9 months; only after 12 months of preservation v_m has increased. This suggests that the determination of storage duration is important, even if the oxygen concentration in the minienvironment is low.

To evaluate the effectiveness of preservation, which is percentage of lipid content being conserved, we have calculated the lipid storage performance over 3, 6, 9, 12 months, Table 1. Variation of preservation efficiency of corn grain lipid as a function of oxygen concentration is represented in Figure 6.

Table 1. Preservation Efficiency of corn grain lipid

oxy, %	3, m	6, m	9, m	12, m
<2	*99.47*	*98.93*	*98.13*	*97.59*
5	*98.66*	*97.86*	*97.06*	*96.79*
10	*96.79*	*95.29*	93.05	91.18
15	*95.19*	89.30	83.16	76.20
21	88.77	77.01	65.51	52.94

The results showed that lipid contents in excess of 95% initial value were found in 2 minienvironments with oxygen content of 2 % and 5 %, during 12 months; however of 10 % and 15 %, only during 6 and 3 months, respectively. In particular, in the minienvironment with oxygen concentration of 15%, the lipid storage efficiency has reached 95.19 % only over a period of 3 months. While in minienvironment at 21 % oxygen level the storage efficiency is low, and reached only 88.77 % at 3 months of preservation, and after 12 months only 52.94%, that means do not guarantee the quality of storage.

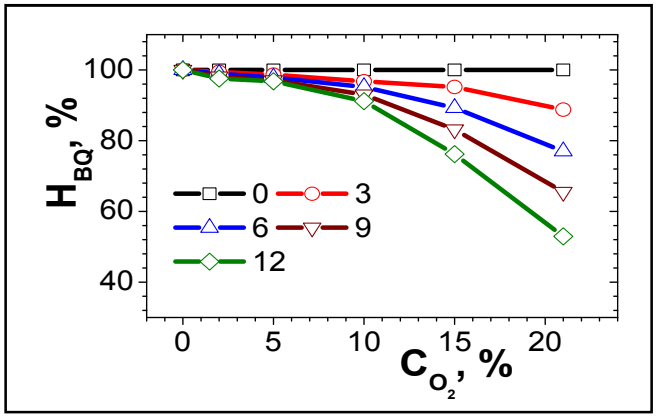

Fig. 6.Variation of storage efficiency of corn grain lipid as a function of oxygen concentration (storage time shown in Figure)

The obtained results allows to confirm that the high oxygen levels in this case are the main cause of lipid depletion, the lower the concentration of oxygen, the slower rate of lipid depletion. The most suitable oxygen concentration to ensure lipid quality is 2-5. %, have a storage time of over 12 months, at oxygen concentration of 10% can be preserved for 6 months, and at 15 % can be stored only for 3 months. Based on these data the suitable storage duration can be determined.

Conclusion

Grain corn has been preserved in the oxygen depleted minienvironment at normal temperature and pressure. Lipid content of the preserved gran cornhas been determined by storage time in order to deal with effects of oxygen concentration on lipid degradation. The obtained results of the study have revealed that the rate of corn lipid degradation

depends on both oxygen concentration and storage time. The lowest lipid degradation rate was found for the preservation in minienvironment with the lowest oxygen concentration <2 %, over 12 months storage. The lowest preservation efficiency for corn lipid is 55,5 %,for the preservation at 20.9% oxygen atmosphere.. To reach efficiency over 95 % the 15% oxygen minienvironment has found being suitable only for a 3 months preservation and the 10 % oxygen minienvironment for the 6 months storage. Minienvironments with < 2% and 5% oxygen can be used for a suitable preservation of 12 months and longer. Especially for the case of oxygen concentration <2 %, preservation efficiency for the corn lipid has found being over 97%.Oxygen concentration plays a decisive role in the reduction of the corn grain lipid. However, with high oxygen concentrations, the rate of the degradation also depends on a series of other factors that interact with each other, including secondary elements, as the products of the bio-oxidation – respiration of corn grain and of other microorganisms, such as mold, insects. These secondary factors manifest an overlapping impact accelerating a polymorphic deterioration and loss of preservation corn.

Acknowledgments

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