BEHAVIOUR OF RAPESEEDS AND SUNFLOWER SEEDS STORED IN AIRTIGHT CONDITIONS. EVOLUTION OF MICROFLORA AND FAT ACIDITY

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INTRODUCTION

Fairly often rapeseeds and sunflower are harvested in France at moisture content higher than 9-10 p.100 (wet weight) ; so they cannot be stored just as they are, without becoming rapidly damaged. This situation is mainly due to the evolution of agricultural and harvesting techniques in connexion with climatic and economic factors such as the late ripeness of sunflower or the necessity to reduce the losses in the field for rapeseed.

During the last ten years, prestorage techniques allowing to wait before drying, without excessive seed degradations have been experimented as well in laboratories as on pilot or industrial scale. Among these techniques, the storage of oil-seeds in airtight conditions seems of particular interest today because of the saving of energy which might be realised.

It seems therefore interesting to recall the behaviour of oil-seeds stored in airtight conditions at different temperature and moisture content levels, the main criteria under examination being the evolution of microflora and the increase of fat acidity. Most of the example given are taken from different laboratory experiments carried on rapeseed and sunflower seeds stored in glass container hermetically closed.

Microbiological analysis which have been restricted to general bacteria and mold counts, are performed in the following manner with a known quantity of seeds, between 50 and 100 g, a suspension is done in a sterile physiological solution. Enumeration of microorganisms is then realised by the classical dilution method using suitable culture mediums. The fat acidity is checked according the french norm (AFNOR NF-V-03-903) on the fat extracted from ground seeds by soxhlet extraction. Results are expressed as fat acidity value (FAV), corresponding to the quantity of potassium hydroxyde necessary to neutralize the acidity of one gram of fat.

1. Influence of storage atmosphere on the microflora evolution

On rape seeds stored under aerated conditions at 12, 15 and 18 P.100 moisture content (22°C), molds are actively growing and sporulating (fig. 1) (Poisson et al., 1971a) and the level of contamination is about 10^7 germs/g within 50 days at 15 and 18 p.100 M.C.

With seeds at 12 p.100 M.C., mold growth is slower but damages become evident within two months.

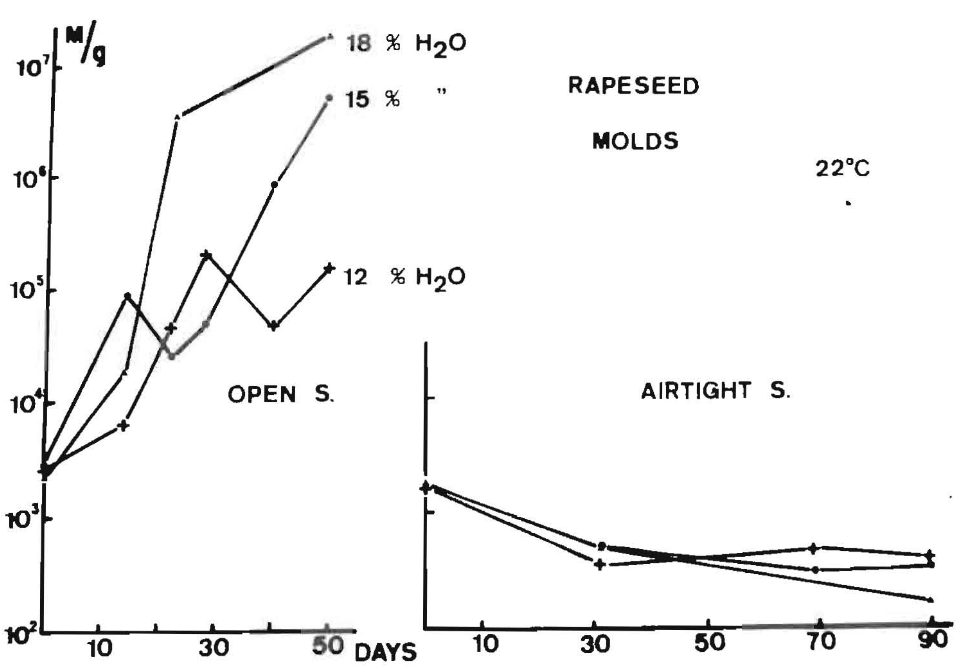

Fig.1. Evolution of molds in rapeseeds stored in air or under airtight conditions.

With rapeseeds at the same moisture content but stored in airtight conditions, no mold growth can be observed during three months. Sometimes a very short period of mold developpment occur in the first days of storage but, as a general rule, the mold population is decreasing because of the lack of oxygen. Under such conditions, bacteria also undergo a regression on seeds stored at 22 p.100 M.C. or less. Microbial evolutions on seeds at higher moisture content have not been investigated.

On fig. 2 (Guilbot and Poisson, 1966), are shown regression curves for molds and bacteria observed on whole sunflower seeds stored in airtight conditions.

As previously observed with rapeseeds, the decrease of microbial populations is more rapid on seeds with higher moisture content, and this evolution is accelerated by an increase in temperature.

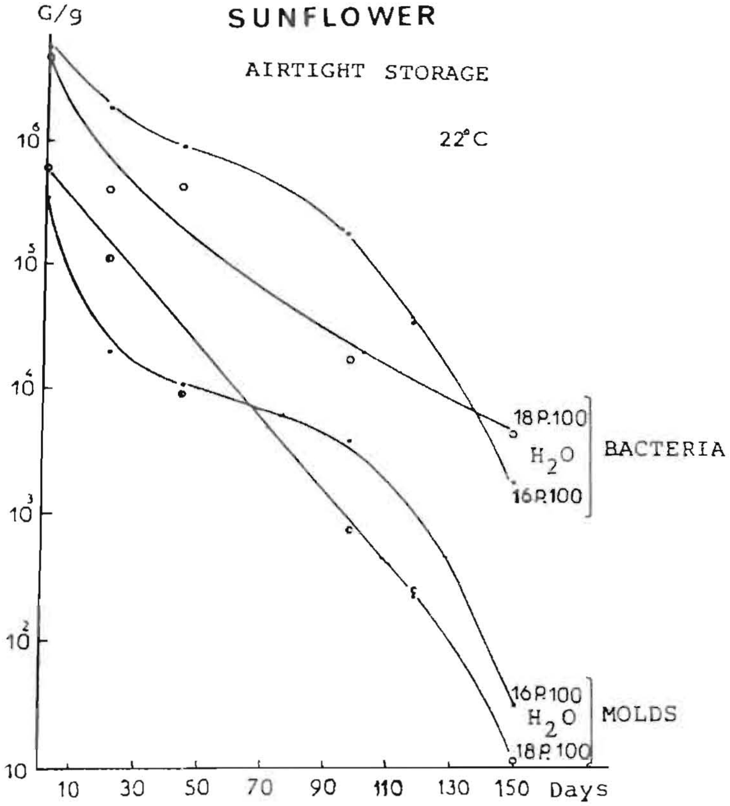

Fig. 2. Evolution of bacteria and molds in sunflower seeds stored in airtight conditions.

2. Effect of storage atmosphere on fat acidity evolution

The fat acidity of oil-seeds is increasing when tey are open-stored but also under airtight conditions. Nevertheless there is a great difference in the intensity of fatty acids liberation, depending on the type of storage. This is true for whole seeds and also for by-products such as oil-cakes.

Fig. 3 (Poisson, 1971b) gives an example of the evolution of fat acidity of rapeseed-cakes, stored at 15 p.100 M.C., in open and airtight conditions ; in spite of the low residual fat content of the cakes, the greater increase in acid number under aerated conditions is clearly shown and can be correlated with the important growth of molds in the product, during the first three months at 22°C.

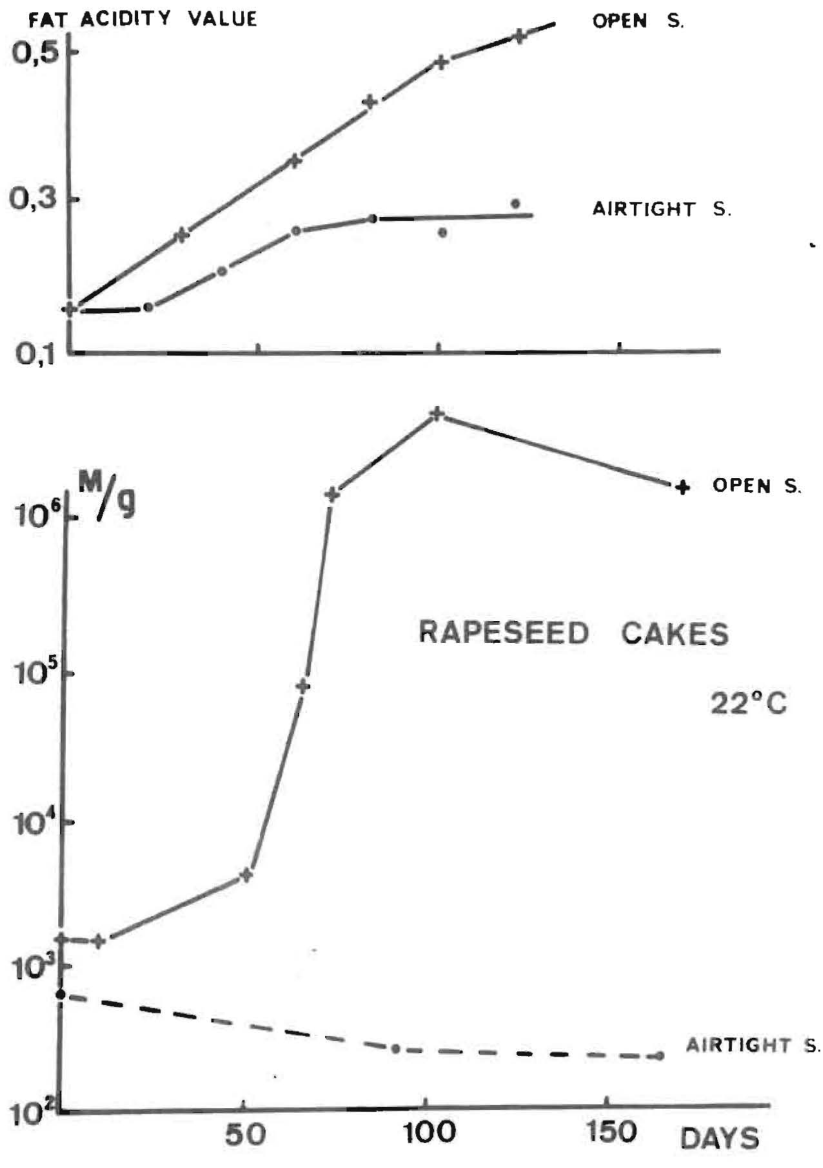

Fig. 3. Fat acidity increase and mold evolution in rapeseed-cakes stored at 15 p.100 moisture content.

There is some evidence that microorganisms, and especially molds, are mainly responsible for the acidification of the oil under aerated conditions : laboratory experiments carried on artificially decontaminated sunflower seeds showed no significant increase of acidity, even at water activities as high as 0,90 (Guenot, 1977).

Considering now broken seeds of sunflower, stored at a moisture content of 6,2 p.100, an interesting behaviour can be observed.

At this moisture content, the kernels, that is to say the seeds without protective shells, are known to be at a water activity of about 0,75 which allows only a very slow growth of storage molds Aspergillus and Penicillium, under aerated conditions. Nevertheless, after two months in open storage the fat acidity is significantly increasing probably due to molds (fig. 4) (Poisson et al., 1972). A lipasic activity of the seed itself might occur but it is very difficult to distinguish molds activity from the possible activity of the seed. In addition, auto-oxidation of fat may occur under such storage conditions.

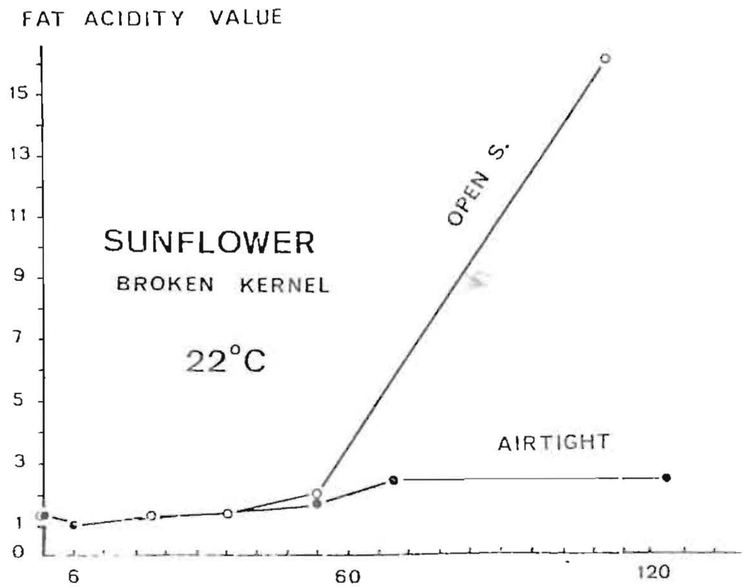

Fig. 4. Evolution of fat acidity of broken kernels under open and airtight conditions.

It is therefore very interesting to notice that in airtight conditions at the same moisture content, the degeneration of oil is strongly repressed and that no increase in fat acidity can be observed.

This protective action of airtight storage is of special interest because it is well known that, even at low moisture contents, broken oil-seeds are very susceptible to rapid storage damage, probably due to a greater diffusibility of enzymes and oil. With storage under oxygen-free atmosphere, the technological value of oil can be practically preserved during at least four months.

2.1. Influence of moisture content on the acidification

The acidification of stored seeds is clearly dependent on the humidity and even a slight difference in moisture content can lead to very different behaviours during airtight storage. This is shown in fig. 5 (Cahagnier et al., 1964) with rapeseeds airtight stored at 11,8 and 14,2 p.100 initial moisture content during one year. After the first six months the fat acidity value remains unchanged in both samples, but after 10 or 11 months the acidification is rapidly increasing in the wet seeds whereas it is still slight in the seeds at 11 p.100 M.C.

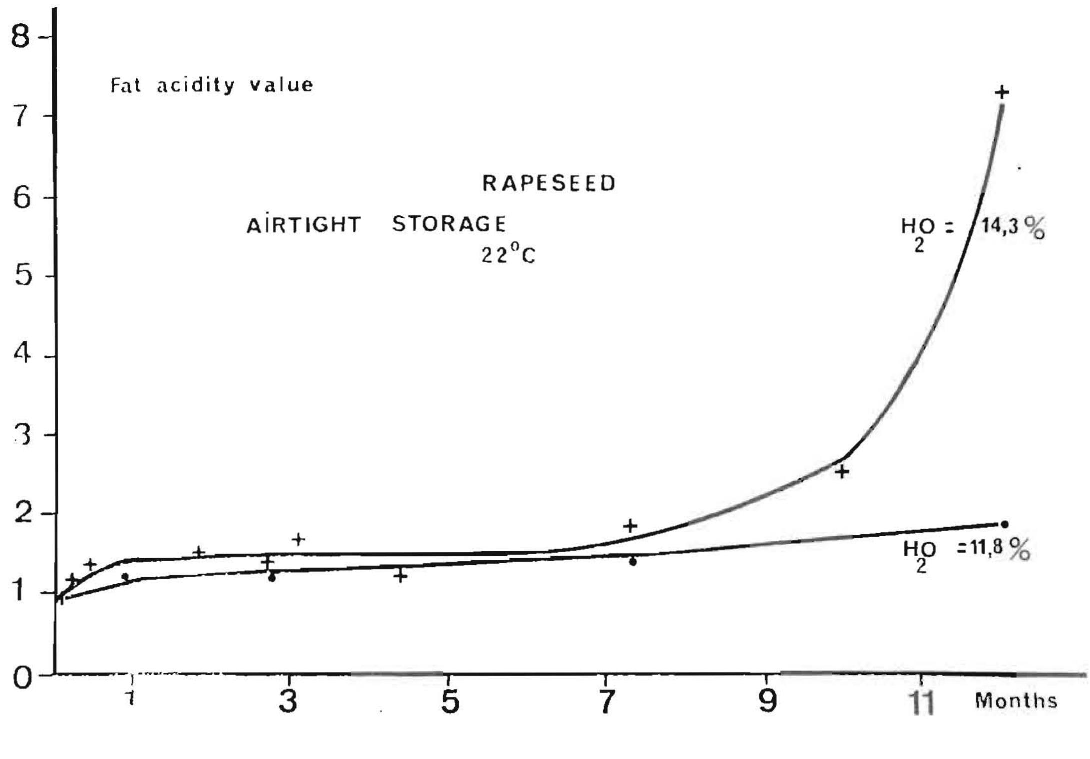

Fig. 5. Influence of moisture content on the fat acidity of rapeseeds airtight stored.

As a consequence, it can be emphasized that the relationship between the acidification rate and moisture content is not linear. These data are in accordance with others (Jouin et al., 1963-1965) obtained on rapeseeds airtight stored at moisture contents between 6,5 p.100 and 25 p.100, with a low initial acidity (0,5 - 1). Provided that the moisture content remains below 15 p.100, there is only a very slight increase of the fat acidity during the first months of storage since the initial value is increasing approximatively twofold after six months.

2.2. Influence of temperature on acidification

With regard to the influence of temperature on fatty acids liberation in oil-seeds during storage, it can be said that the rate of acidification is greater at higher temperature, but the fat acidity evolution is always slower in airtight conditions that in open storage. An example is given in the fig. 6 (Poisson et al., 1972) which show

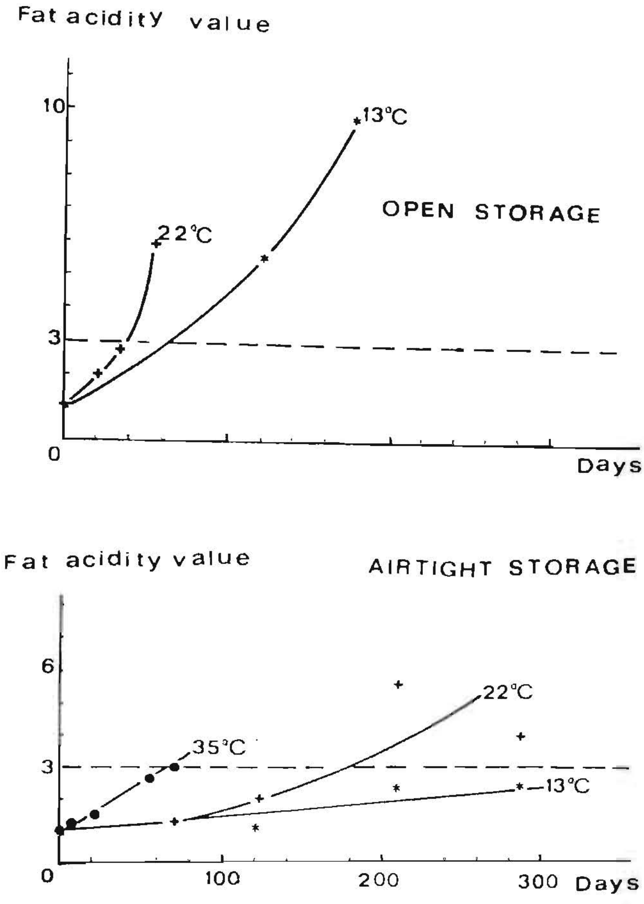

Fig. 6. Sunflower kernels. Evolution of fat acidity

the evolution observed with sunflower at 6,2 p.100 moisture content : during open storage, the acid number reach the limit value of 3 within about two months, whereas this value is not reached under airtight conditions after ten months.

3. Organoleptic qualities of airtight stored seeds

If airtight storage of oil-seeds is ensuring a satisfactory preservation against moulding and fat acidification during significantly longer periods of time than storage under aerated conditions, it must be pointed out that at critical high moisture content and temperature, the seeds undergo a lot of modifications and especially the formation of off-odors, and over-pressure in the containers. Such modifications may be due to some microbial fermentations but also to deviated metabolisms of the seed itself.

Fortunately off-odors in the stored seeds seem to have no repercussion on oil quality, but it may not be the same for products like oil-cakes which are used in animal feeding.

In each case of off-odors formation it has been observed that the organoleptic modifications occur a long time before the beginning of fat acidity increase ; so off-odors detection could be a criterion much more sensitive than acidification for storage damages in airtight conditions of the seeds.

4. Preservation diagrams

Taking into account the most widely used criteria for seed damage assessing, i.e. microorganisms enumeration, fat acidity and germinative capacity for storage in air and fat acidity and off-odors formation for airtight storage, it has been possible to draw up comparative diagramms for rapeseed and sunflower seed preservation (Masson, 1969). This is shown in fig. 7 on which the upper curves represent the limits for airtight stored seeds and the lowers correspond to open storage. Sunflower seeds, for instance, can be securely stored in airtight conditions at 10 p.100 moisture content during more than six months whereas in open storage they will be damaged within less than six weeks.

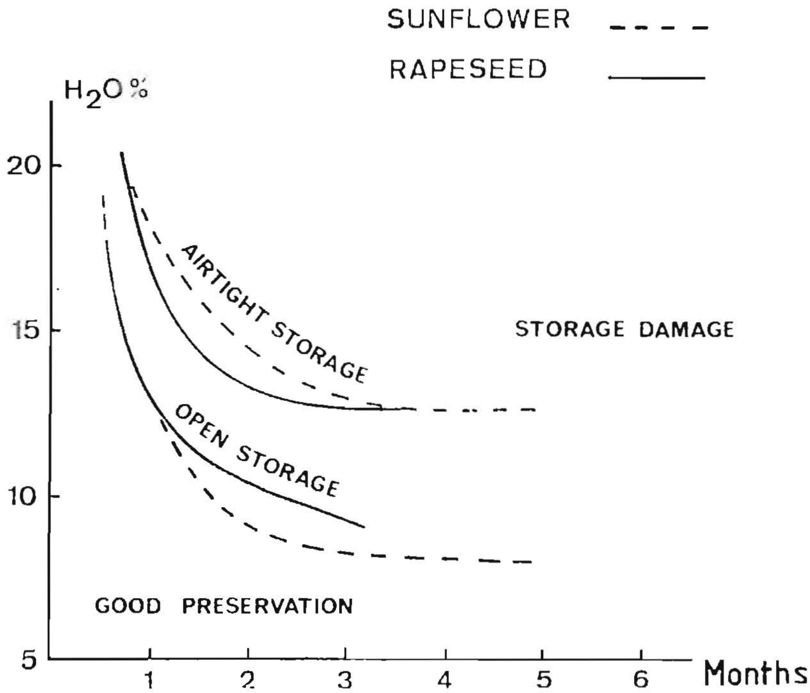

Fig. 7. Preservation diagramm for sunflower and rapeseed (fat acidity value below 1,5).

CONCLUSION

As previously indicated, whatever the moisture content of seeds could be, the period of preservation is always longer under airtight condition than in open storage. The higher the moisture content is, the smaller is the difference but for rapeseeds as well as for sunflower seeds with moisture content from 7-8 to 13-15 p.100 M.C., airtight storage is of real practical interest especially if the seeds are split or broken.

With high moisture seeds, airtight storage leads to off-odors formation due to microbial fermentations. Such organoleptic modifications might be objectionable for oil-cakes used in animal feeding and further investigations are needed in this direction.

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