EVALUATION OF OXYGEN ABSORBER ON ANTIMICROBIAL PRESERVATION OF LASAGNA-TYPE FRESH PASTA UNDER VACUUM PACKED

Avaliação de absorvedor de oxigênio na inibição do crescimento microbiano em massa fresca de *lasagna* embalada a vácuo

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ABSTRACT

O_2 absorbent system was evaluated on the inhibition of microorganisms growth in fresh lasagna pasta during storage at 10±2ºC. Fresh lasagna pasta was produced with and without potassium sorbate and acondicionated in high O_2 barrier bags containing a O_2 - absorber sachet in the head-space. Three treatments were obtained: pasta with potassium sorbate, pasta without potassium sorbate packed with sachet and pasta without potassium sorbate packed without sachet. In all treatments, the pasta were vacuum packed, randomly distributed at temperature of 10±2ºC and microbiologically evaluated for molds and yeast, *Staphylococcus* spp, total coliforms and *Escherichia coli* countings. All the treatments were effective in inhibiting the growth of the microorganisms evaluated during 30 storage days. The treatment using O_2-absorber in the pasta without preservative, inhibition of 1 and 1.5 logarithmic cycles was observed for the molds and yeasts and *Staphylococcus* spp, respectively. No differences were observed among treatments for coliforms countings.

Index terms: Active Packaging, Oxygen Absorber, Microbial Inhibition, Fresh Pasta

RESUMO

Foi avaliado o sistema de absorvedor de oxigênio para inibição de microrganismos em massa fresca de lasagna durante estocagem a 10±2ºC. A massa de lasagna foi produzida com e sem sorbato de potássio e acondicionada em embalagens com alta barreira a oxigênio contendo um sachê absorvedor em seu interior. Foram avaliados três tratamentos: massa com sorbato de potássio (1), massa sem sorbato de potássio e com sachê absorvedor de oxigênio (2) e massa sem sorbato de potássio e sem sachê absorvedor de oxigênio (3). Em todos os tratamentos, a massa foi envasada a vácuo e distribuída aleatoriamente sob temperatura de 10±2ºC e avaliada microbiologicamente quanto o crescimento de bolores e leveduras, *Staphylococcus* spp, coliformes totais e *Escherichia coli*. Todos os tratamentos foram efetivos na inibição do crescimento dos microrganismos avaliados durante o período de 30 dias de armazenamento. O tratamento 2 inibiu o crescimento de bolores e leveduras e *Staphylococcus* spp, em 1 e 1,5 ciclos logarítmicos, respectivamente. Não houve diferença significativa para coliformes em todos os tratamentos.

Termos para indexação: Embalagem ativa, absorvedor de oxigênio, inibição microbiana, massa fresca.

(Recebido para publicação em 21 de dezembro de 2005 e aprovado em 27 de junho de 2006)

INTRODUCTION

Maintaining the quality of a food product and, consequently, its preservation, is based principally on the inhibition or prevention of microbial growth (ALLARCON & HOTCHKISS, 1993). Food can still be preserved by the addition of antimicrobial substances that prevent or inhibit the development of microorganisms. However consumers are currently demanding products that have better ‘’in natura’’ qualities.

Microbiota growth is determined by the presence of oxygen, favoring the growth of aerobic organisms and, consequently, the lack of oxygent will allow facultative anaerobes to become dominant.

The presence of oxygen inside the packages is due to flaws in the packaging process, such as mixture of gases containing oxygen residues, inefficient vacuum, as well as high permeability - oxygen rates of the package utilized. Thus, packaging research and developments have been carried out aiming at elimination of residual oxygen.

Within this context, the concept of active packaging has been introduced. This technology involves an interaction of the package with the product, modifying its properties as desired. This new concept of packaging includes the O_2 absorbers (BERENZON & SAGUY, 1998; HAN, 2002; VERMEIREN et al., 1999), also called deoxidizers or oxygen scavengers.

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Overall, the absorber technology is based on oxidation or combination of one of the following components: iron powder, ascorbic acid, photosensitive polymer, enzymes, among others (FLOROS et al., 1997; LABUZA & BREENE, 1989; ROONEY, 1995; VERMEIREN et al., 1999).

According to Abbott (2002), one of the main advantages of using absorbers is their capacity to reduce the O_2 levels to less than 0.01%, which is lower than those typically found (0.3-3%) using traditionally modified atmosphere packaging (MAP) vacuum packaging or substitution of the internal atmosphere by inert gas. Thus, this method has attracted interest as a novel packaging technology applied to reduce the oxygen level inside the packages to preserve food quality (ABE & KONDOH, 1989; NAKAMURA & HOSHINO, 1983). The method prevents the growth of aerobic microorganisms, delays oxidation of lipids and flavor compounds and may still replace chemical pesticides to prevent damage caused by larvae and insects. Some of its disadvantages are the possibility of packaging collapse which can be avoided by using an O_2 absorber and CO_2 generator system. In the case of absorbers in sachet form, one can also cite the need of free airflow around the sachet to enhance the O_2 scavenging capacity inside the package (AZEREDO et al., 2000; SMITH et al., 1990, 1995).

In bakery products, molds are the major deteriorating agents. Besides the visual repulsion caused by their growth, these microorganisms are responsible for an undesirable flavor and production of mycotoxin and allergic compounds.

Some data have shown an extension of the shelf-life of these products with the use of O_2 absorbers, especially iron powder based O_2 absorbent sachets (NAKAMURA & HOSHINO, 1983). A research work showed that the use of these sachets was a more efficient alternative than that of nitrogen atmosphere in the control of *Aspergillus niger* and *Penicillium* spp, common contaminants of bakery products (SMITH et al., 1986). The study revealed that in products packed with air, nitrogen and CO_2/N_2 (60:40), a visible growth of fungi occurred after 9, 11 and 16 days, respectively. When using the same atmospheres modified associated with O_2- absorber sachet, mold growth was not visible up to 60 storage days at 25C. The package utilized was nylon and polyethylene laminate with mean permeability of 40 $cm^3.m^{-2}day^{-1}$ for O_2, 14 $cm^3.m^{-2}day^{-1}$ for N_2 and 155 $cm^3.m^{-2}day^{-1}$ for CO_2, at 25C and 100% relative humidity.

The objective of this work was to evaluate the efficiency of a commercial oxygen absorber system in inhibiting the growth of molds and yeasts, *Staphylococcus* spp, total coliforms and *Escherichia coli* countings in lasagna, type fresh pasta.

MATERIAL AND METHODS

An iron based O_2 absorbent system in sachet form, was utilized. The model was the FT-300, meant to be used in products with maximum water activity (aw) of 0.85, with capacity to absorb up to 300 mL of oxygen, according to the manufacturer. The basic ingredients used in the pasta production were: wheat flour, oil, salt and water and potassium sorbate as chemical preservative.

The fresh pasta was produced in a local industry and two bulks were prepared: with and without potassium sorbate. The pasta was vacuum packed in a commercially used, multi-layered package made of polivinylidene (PVdC) and poliethylene (PE), 80 µm thick, 53 g/m^2 and 8.63 cm^3/m^2.day.atm of permeability to O_2. Package permeability was determined in the equipment Oxtran 2/20 (MOCON) at 23 ^oC. All the pasta was vacuum packed. The bags containing the pasta without sorbate an O_2-absorber sachet was added in the head space of the package. The treatments were randomly divided and stored at a cooling temperature (10±2 ^oC).

Pasta samples of the different treatments were submitted to molds and yeast (FCU/g), total coliforms and *E. coli* (NMP/g) and *Staphylococcus* spp (FCU/g) countings, according to APHA (VANDERZANT & SPLITTSTOESSER, 1992). Water activity in the fresh pasta was performed using the equipment Aqualab, at 25 ^oC. The averages of the microbiological counts were compared by Tukey test.

RESULTS AND DISCUSSION

All the treatments were efficient in inhibiting the growth of molds and yeasts, at 10±2 ^oC, for 45 days, since the maximum count of 10^4FCU/g established by the Brazilian legislation was not reached (Figure 1). However, until the 30th day, the absorber treatment was the most efficient ($p<0.05$) with a count around 10^2 FCU/g of molds and yeasts.

The molds commonly found in fresh lasagna pasta are strictly aerobic and should not grow in the products when vacuum-packed. However, as pointed out by Hotchkiss (1988), Rooney (1995) and Vermeiren et al. (1999), this technique does not eliminate all the oxygen from the package and does not control the oxygen permeated through it. Therefore, the existence of residual oxygen occurs under vacuum packaging conditions, allowing the growth of these microorganisms.

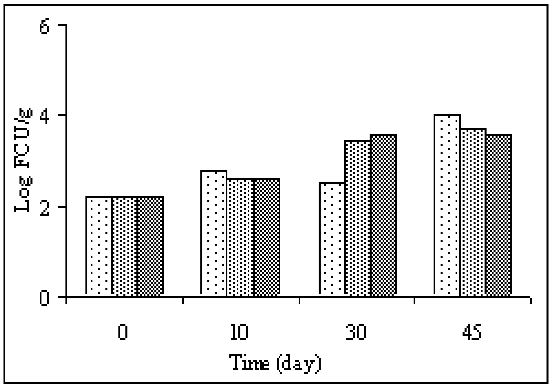

FIGURE 1 – Decimal logarithm of the number of molds and yeasts (FCU/g) in lasagna type fresh pasta (Absorber; Vacuum; Chemical preservative). Averages followed by the same letters do not differ by Tukey test ($p < 0.05$).

According to Cruz (2003) the oxygen rate of the O_2-absorber sachet is 312.50 cm^3/day, higher than the oxygen permeability rate of the bag (0.518cm^3/day). Therefore, the sachet contributed to maintain a low oxygen concentration inside the bags containing the sachet, what explain the lower molds and yeasts countings until the 30th day of storage.

The treatment using chemical preservative shown to be efficient in inhibiting the growth of molds and yeasts for 45 days. The chemical preservative, sorbic acid, not only inhibits growth but also eliminates vegetative cells. This preservative is added as salts, such as potassium sorbate, which, when in contact with water, return to its acid form, penetrating in the microorganism cell in non-dissociated form. The dissociation of the acid occurs in the microbial cytoplasm, leading to a lowering of the intracellular pH, causing the destruction of the microorganism. Thus, the preservative decreases the number of viable cells, thereby extending the shelf life of the product.

Staphylococcus spp are facultative anaerobic microorganisms, which grow between –150 and + 50 mV. Hence, restricting the oxygen, e.g., with vacuum application only, would not be sufficient to inhibit it. It was observed in this experiment that the use of vacuum in conjunction with O_2 absorber was the most efficient treatment ($p<0.05$) to inhibit the growth of this microorganism up to 30 days, when the *Staphylococcus. spp* count was around 1.5 logarithmic cycles smaller (Figure 2) than the other treatments. It should be mentioned that the initial counting of *Staphylococcus* spp was $1x10^2$ FCU/g and the Brazilian regulation specify the maximum counting of $5x10^3$ FCU/g for this microorganism (ANVISA, 2000).

The growth of total coliforms did not present significant difference ($p<0.05$), among the treatments until the 30th day of storage.

Even though vacuum packed lasagna pasta presented the lower coliforms counting ($p<0.05$) after 45 days (Figure 3), the treatments did not reach the count of 10^2 NMP/g, established by the Brazilian legislation. It should also be mentioned that for all the treatments *E. coli* count was lower than 3 NMP/g, over the 45 storage days.

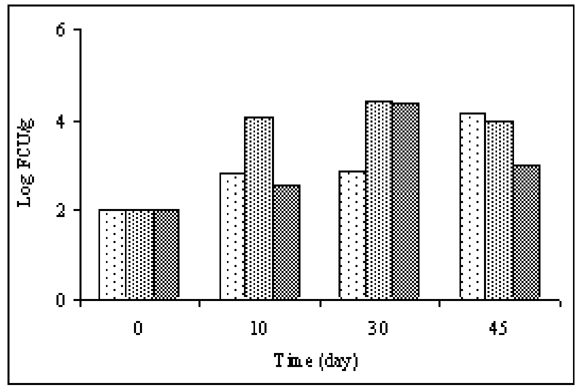

FIGURE 2 – Decimal logarithm of the number of *Staphylococcus spp* (FCU/g) of lasagna type fresh pasta (Absorber; Vacuum; Chemical preservative). Averages followed by the same letters do not differ statistically by the Tukey test ($p < 0.05$).

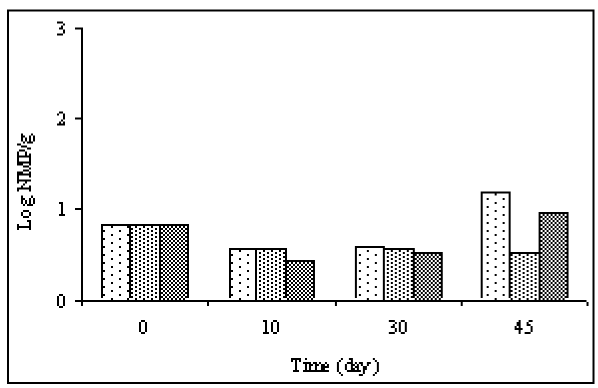

FIGURE 3 – Decimal logarithm of the number of of total coliforms (NMP/g) of lasagna type fresh pasta (Absorber; Vacuum; Chemical preservative). Averages followed by the same letters do not differ statistically by the Tukey test ($p < 0.05$).

CONCLUSION

Oxygen absorbers were efficient in controlling the growth of filamentous fungi and yeasts, *Staphylococus spp*, total coliforms and *E. coli*. in lasagna type fresh pasta without the addition of potassium sorbate, vacuum- packed in O_2 - absorbent sachets, stored at 10±2 °C. The count of these microbial groups did not reach the maximum values of $1.0x10^4$ FCU/g, $5x10^3$ FCU/g, and$1.0x10^2$ NMP/g established by the RDC no. 12 of the Brazil, respectively for these microorganisms, up to 30 storage days. Therefore, the O_2-absorber sachet can be used as a hurdle technology, associated with vacuum packaging and applying the good manufacturing pratices, to preserve lasagna pasta without additives.

ACKNOWLEDGEMENTS

The financial support by CNPq, FAPEMIG and FINEP is gratefully acknowledged.

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