Evaluation of Stability of Alginate-coated Mango Cubes Preserved by the Combined Methods Technology

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Abstract. The combined methods technology (CMT) consists of combining low levels of several preservation factors acting synergistically to inhibit microbial growth. The aim of this work was to evaluate stability of alginate-coated mango cubes submitted to the following methods: water activity reduction, pH reduction and addition of a chemical preservative. The cubes, previously dipped in sodium alginate and calcium chloride to form a calcium alginate coating, were osmotically dehydrated at 44°C in a 65.5°Brix sucrose solution with 2% citric acid and 0.2% potassium sorbate for 2 hours. The product was packaged in low-density polyethylene bags and stored under refrigeration for 3 months. The combination of methods was not enough to make the product stable, since the count of yeasts and molds increased. The cubes lost moisture and color during storage. The acceptance of the product decreased with storage time, although the mango flavor intensity did not change significantly.

Resumo. A tecnologia de métodos combinados (TMC) consiste na combinação de baixos níveis de vários fatores de conservação, que agem sinergicamente para inibir o crescimento microbiano. O objetivo deste trabalho foi avaliar a estabilidade de cubos de manga revestidos com alginate e submetidos aos seguintes fatores antimicrobianos: redução da atividade de água, redução do pH e adição de um conservante químico. Os cubos, previamente imersos em soluções de alginate de sódio e de cloreto de cálcio para formar a película, foram osmoticamente desidratados a 44°C em solução de sacarose a 65,5°Brix, adicionada de 2% de ácido cítrico e 0,2% de sorbato de potássio, durante 2 horas sob agitação. O produto foi embalado em sacos de polietileno de baixa densidade e estocado sob refrigeração por 3 meses. A combinação de métodos utilizada não foi suficiente para manter a estabilidade do produto, já que a contagem de bolores e leveduras aumentou. Os cubos perderam umidade e cor durante a estocagem. A aceitação do produto diminuiu com o tempo de estocagem, embora a intensidade de sabor de manga não tenha sofrido alterações significativas.

Approximately 26 thousands MT of mango were produced worldwide in 2002 (FAO, 2003). In spite of the low stability of the fresh fruit and its seasonal supply, the share of its production that is processed is very limited. The traditional fruit preservation methods are generally based on one antimicrobial factor, which is applied at such a level that changes the sensory characteristics of the fruit. The combined methods technology (CMT), on the other hand, is based on a simultaneous application of low levels of various preservation factors, which act synergistically to result in a stable product. The sensory changes resulting from CMT are minimal, and the final products are quite similar to the corresponding fresh fruits (Aguilera and Chrife, 1994). With CMT, osmotic dehydration is a technique generally used to reduce water activity of fruit. It consists of placing the fruit in a hyperconcentrated solution. Besides losing water, the fruit also gains solids, although this is undesirable since it results in noticeable sensory changes (Azoubel and Murr, 2000). The previous application of a calcium alginate coating on the fruit surface favors water loss and reduces solid gain, thanks to the hydrophilic characteristic of alginate (Camirand et al., 1992). The objective of this work was to evaluate the stability of alginate-coated mango cubes submitted to the combination of the following preservation methods: water activity reduction, pH reduction, presence of potassium sorbate (chemical preservative) and storage under refrigeration.

Material and Methods

The ‘Tommy Atkins’ mango, purchased in the local market (Fortaleza, CE, Brasil), were washed, sanitized, peeled, cut in cubes and sequentially dipped in 1.5% sodium alginate (provided by Danisco Ingredients Brasil, Embu, SP) and 2.4% calcium chloride, for 30 and 60 s, respectively. The coated cubes were then osmotically dehydrated in a 65.5°Brix sucrose solution with 2% citric acid and 0.2% potassium sorbate; dehydration was carried out in an open kettle (stainless steel) at 44°C with stirring for 2 hours. The sucrose solution was then drained in a sieve for 2 minutes. The temperature and concentration of osmotic solution were defined from previous results (Araújo et al., 2003). The dehydrated cubes were packaged in low-density polyethylene bags and stored refrigerated. The product was analyzed immediately after processing and monthly during storage. The physico-chemical determinations were water activity, pH, total titratable acidity, moisture and soluble solid contents (IAL, 1985) and potassium sorbate content (Mauro, 1992). The microbiological analyses were determination of total and faecal coliforms and Escherichia coli, counts of yeasts and molds, determination of mesophilic aerobes and Salmonella research, according to American Public Health Association (Downes and Itô, 2001). The sensory analyses were made according to Meilgaard et al. (1997). Thirty non-trained panelists took part in two kinds of tests: the acceptance was evaluated in terms of appearance, flavor and texture, by using 9-point structured hedonic scales (1 - disliked extremely to 9 - liked extremely), and the mango flavor intensity was evaluated by means of a 7-point structured scale (1 – too weak to 7 – too strong). The significance of the sensory changes with storage time was evaluated by regression techniques and analysis of variance (PROC GLM, SAS, 1993). The means of the attributes which presented significant variations (p<0.05) were submitted to Tukey’s multiple range test, also applied to the physico-chemical attributes.
Results and Discussion

The osmotic dehydration resulted in 43.21% weight loss, 48.32% water loss and 5.10% solid gain. The water activity was only slightly reduced, from 0.986 to 0.976. pH was reduced from 4.4 to 3.9. The potassium sorbate content of the final product was 330 mg/kg. The results of the physico-chemical analyses of the product during storage are presented in Table 1. A significant moisture loss was observed, which reduced water activity and increased soluble solid content. pH and acidity did not significantly change. The reduction in the color parameters a* and b* indicates loss of orange color. The acceptance of the product decreased throughout the storage time, although their hedonic scores had remained within the acceptance region, namely, higher than 5 in the hedonic scale (Table 2). The mango flavor intensity was near 4 in a 7-point scale since the beginning of the storage time. This suggests that the product might have lost volatile compounds responsible for mango flavor during osmotic dehydration. As the mango flavor intensity did not change significantly with time, the slight decrease in flavor acceptance may be attributed to some off-flavor developed during storage.

The results of the microbiological analyses are presented in Table 3. During 3 months of storage the product remained safe, according to the Brazilian legislation concerning microbiological standards for glazed fruits (Brasil, 2001). Although this legislation does not establish limits for counts of mesophilic aerobes and for yeasts and molds, these determinations were carried out in order to evaluate the product stability. The counts of mesophilic aerobes were lower than 10 UFC/g during 3 months, but the determination of yeasts and molds increased from less than 100 UFC/g to values of about 10^4-10^5 UFC/g. For this reason, the stability evaluation was interrupted at 3 months of storage, and the product was considered not stable. Neither pH nor water activity would alone be able to provide stability to the product. The pH slightly lower than 4 could inhibit bacterial growth, but not yeasts and molds (Alzamora, 1994). Water activity was very high and unable to inhibit bacterial growth (Troller, 1980). However, the combination of these two factors with the added sorbate and storage under refrigeration was expected to assure the product stability for some months. According to Chanes et al. (1994), several stable fruit products were obtained by method combinations similar to the used in this work; however, the sorbate concentrations of the final products (about 1000 mg/kg) were higher than that of the mango cubes in this work (330 mg/kg). So, it is recommendable that future works involve higher preservative concentrations or a combination of preservative agents.

Conclusions

Although the product was microbiologically safe during 3 months of storage, increases in counts of yeasts and molds were reported, indicating that it was not stable. A slight reduction in the moisture content of the product, as well as loss of orange color, were reported to occur during storage. The acceptance of the mango cubes decreased with storage time, although remaining within the acceptance region. The mango flavor intensity did not decrease significantly.

Literature cited


