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MICROENCAPSULATED CINNAMON AROMA DETERMINED BY 'ELECTRONIC NOSE'

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In the present study, a microencapsulation technique, extrusion, has been used to entrap the cinnamon aroma in a matrix containing different percentages of maltodextrin, modified starch and β-cyclodextrin at different moisture contents. Afterwards the obtained microencapsulated powders have been analyzed on an electronic olfactory system, electronic nose system FOX 4000 combined with HS100 auto-sampler to see the aroma intensity of the obtained powders. Based on the results, it is easy to see the differences between the control and the microencapsulated samples flavor intensity, and that β-cyclodextrin had an important role in the encapsulation of cinnamon volatile aroma.

Keywords: electronic-nose, microencapsulation, extrusion, cinnamon

1. Introduction:

The quality and quantity of flavors and spices play an important role in the food industry nowadays, influencing in many cases the consumers'choice and their level of acceptance of different types of foods [1-3].

Pleasing warm spicy aftertaste and preservative properties have made cinnamon aroma very attractive as a fragrance and especially as a food flavoring from ancient times, used as breath freshner or for embalming by ancient egyptians [3]. It has been used as a traditional treatment for thousand of years [4].

Nowadays it is recognized for its medicinal properties: helping in digestion, good diuretic, anti-ulcer, anti-inflammatory, anti-microbial, anti-oxidant, hypoglycemic and hypolipidemic potential, safe and useful in allergic conditions, and may be effective in the treatment of cancer [5-7]. Many studies confirm that cinnamon supplementation has potential effectiveness in the treatment of type 2 diabetes, by improving blood glucose control in the recruited patients [8]. Studies performed in the United States also confirmed that cinnamon improved the levels of hemoglobin A_{1C} (HbA_{1C}) in type 2 diabetic patients [9].

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To protect the cinnamon aroma on the various technological flows in the food industry, the extrusion microencapsulation technique can be used to encapsulate volatile and unstable flavors [10]. Extrusion was first patented in 1957, and it is recognized as „a true encapsulation method", because in this process the core is completely surrounded with wall material [11]. Extrusion method is suitable for flavor microencapsulation, using mostly sugars and starch as wall materials [12].

The aim of this work was to establish a procedure for cinnamon microencapsulation using different coatings based on maltodextrin, modified starch and β-cyclodextrin and to assess the efficiency of the applied microencapsulation method. In this respect, a fast, accuracy and high sensitivity system was used - the electronic nose (e-nose) [1, 13, 14]. The e-nose system consists of an array of various electronic chemical gas receptors with partial specificity, that is cappable to recognize simple or complex volatile chemicals (odours) [14, 15]. Among scientist it is known by many other names, such as, 'aroma sensor', 'flavour sensor' [16], 'multi-sensor array technology' [17], 'odour sensing system' [18].

2. Materials

Cinnamon powder (bought from a local supermarket) was microencapsulated in a mixture of maltodextrin (GLUCIDEX® 19, ROQUETTE FRERES, 62136 Lestrem, France), modified starch (EMJEL EP 820 C, EMSLAND, Germany) and β-cyclodextrin (Zhengzhou Sigma Chemical Co., LTD., Henan, China). These coating materials were chosen due to their protective properties regarding the encapsulation of flavors [19, 20], through extrusion processing [21, 22].

Cyclodextrins have been used for their unique ability to host molecules due to their hydrophobic interior, trapping them by induced dipoles and Van der Waal interactions [23], and protecting them from flavour losses [24].

Eleven mixture samples (Table 1, P1-P11) were prepared for microencapsulation with different percentages of maltodextrin, modified starch and β-cyclodextrin and the same amount of cinnamon, at two different moisture values (aprox. 17% for P2 – P6 and aprox. 12% for P7 – P11). The P1 sample, because of the high moisture percentage could not be extruded. The control sample (M) was pure cinnamon (Table 1).

Table 1

Sample preparation weights and moisture

No.	Ingredients	Samples											
		M	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
1.	Maltodextrin, g	-	240	240	-	-	-	-	240	-	-	-	-
2.	Modified starch, g	-	27	27	267	274	260	246	27	267	274	260	246

3.	β-cyclodextrin, g	-	7	7	7	-	14	28	7	7	-	14	28
4.	*Cinnamon, g*	*X*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
5.	Water, ml	-	58	29	29	29	29	29	14.5	14.5	14.5	14.5	14.5
6.	Moisture, %	-	-	17.05	17.32	17.20	17.60	17.54	12.20	12.34	12.31	12.44	12.51

3. Instrumentation:

The microencapsulation by the extrusion method was realised on a pilot scale single-screw Brabender extruder (Model KE 19/25D, Brabender® GmbH, Duisburg, Germany). A 5mm cylindrical die-nozzle was used and a 2:1 compression ratio screw was used.

The electronic nose system FOX 4000 combined with HS100 auto-sampler together with a Soft version 8.0 software for data processing (Alpha M.O.S., Toulouse, France) was employed to study the headspace of samples. The system comprised of an array of 18 metal oxides sensors (MOS) placed in three controlled temperature chambers.

The moisture was determined for all the microencapsulated samples using a Mettler LJ16 Moisture Analyzer.

4. Procedures:

The extrusion process was conducted at barrel temperatures of 40, 70, 100 and 130^{o}C. Screw speed was maintained at 80 rpm and 15 rpm feeder speed.

After extrusion the samples were left to cool at room temperature (aprox. 22^{o}C) for 24h. After cooling the samples were milled on a Brabender Quadrumat Junior (Brabender® GmbH, Duisburg, Germany) laboratory mill.

Before performing the analyses, the electronic nose system was calibrated using a standard (solutions in water) testing kit based on: propanol 0.1%. acetone 0.1% and iso-propanol 0.005%.

2 g of each sample were placed in a 10 mL vial that was hermetically capped with a PTFE/silicone septum and incubated for 300 s at 50°C under agitation (250 rpm) for headspace generation. Synthetic air and nitrogen were used as carrier gas with a flow of 150 mL/min. A 1000 μL volume was injected at an acquisition time of 120 s. The measurements were done in triplicate for each sample (Fig. 1).

5. Results and discussions

Based on the PCA (Principal Component Analysis) of the electronic nose software, the samples were all well differentiated in terms of the overall volatile composition (Fig. 1), with a very good discrimination index value of 92 out of 100.

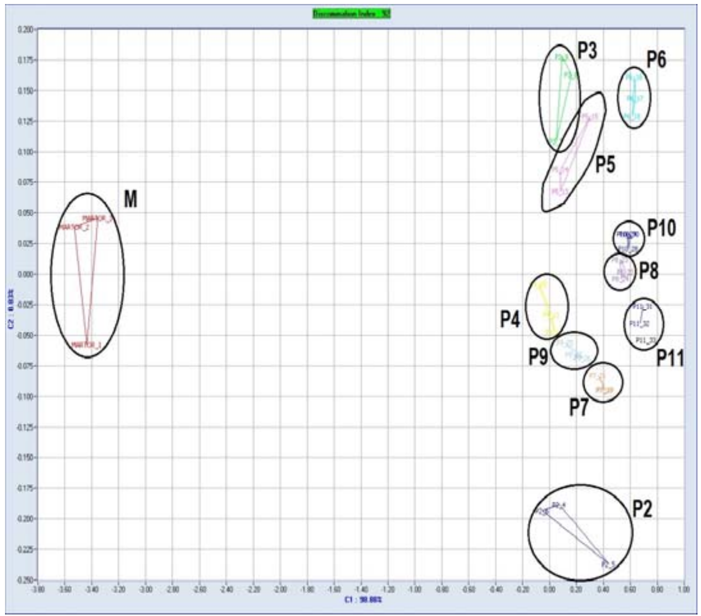

Fig. 1. Discrimination between samples

The sensors answer was analysed to interpret the intensities of the volatile compounds. Fig. 2 presents a comparative image of sensors signals between the control (M) and sample P6 which clearly shows the differences detected by the 18 metal oxides sensors in terms of the volatile composition for the two samples.

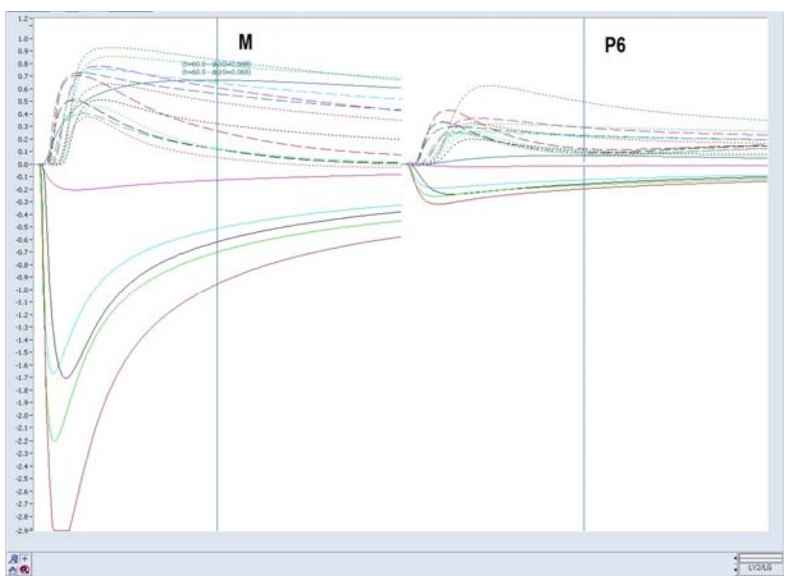

Fig. 2. Signals of the 18 sensors for samples M and P6

The differences between samples P6 and P11 are not significant if we analyse Fig. 3 which shows the sensors answers for this two samples. This means that the samples are similar. The small differences in the amount of water and the final humidity didn't influence too much effect the binding process of cinnamon. Also. these samples had the highest quantity of β-cyclodextrin as coating material. which has a good effect to bind the flavour compounds.

In comparison with the control sample (M), it is clealry visible in Fig. 2 that the obtained intensities for P6 and P11 are much lower, which means that the volatile composition in these samples is realesed heavily than in the control, so the coating materials have a goos effect in protecting the cinnamon aroma.

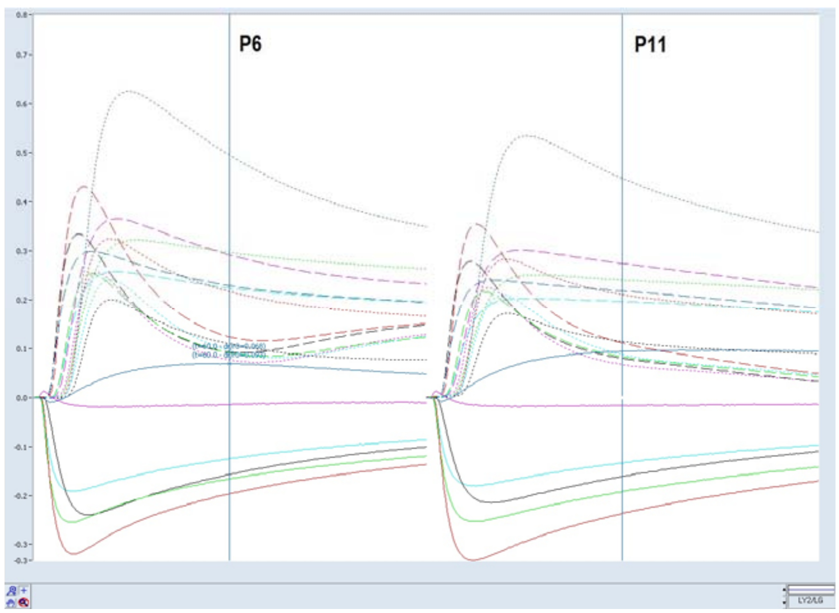

Fig. 3. Signals of the 18 sensors for samples P6 and P11

It can be concluded that P6 and P11 are the samples with the smallest volatility intensity, so with the better effect on entrapping the aroma.

The most unaffective microencapsulant effect had the samples P4 and P9, whose recipes did not contain β-cyclodextrin. The graphic showing the difference between P4 and P6 can be seen in the Fig. 4.

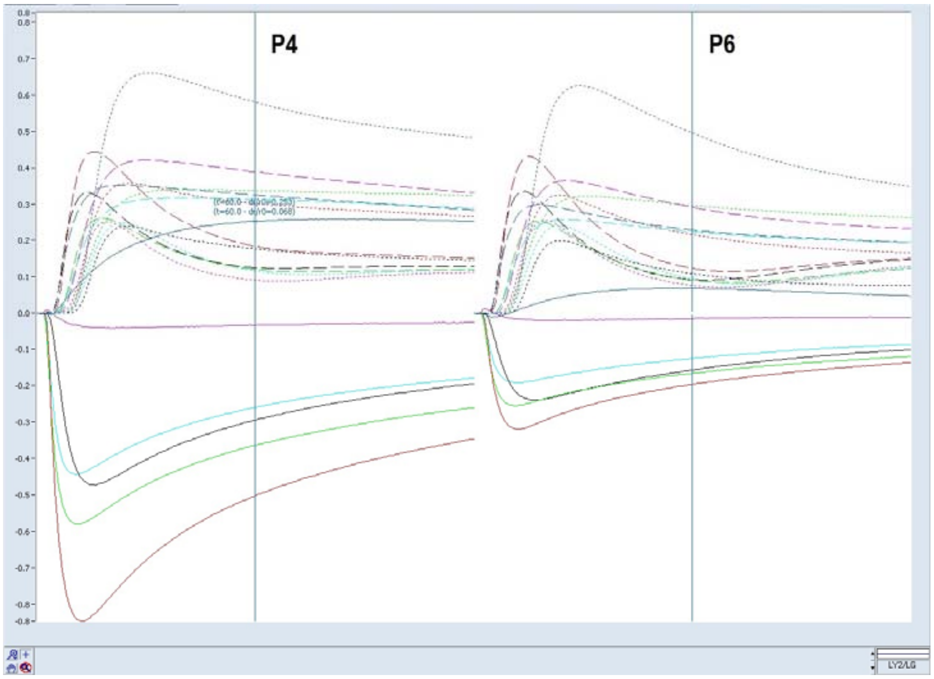

Fig. 4. Signals of the 18 sensors for samples P4 and P6

6. Conclusions

The aim of this study was to find a procedure for protecting cinnamon flavour against oxidation, heat, light, evaporation in the techological flows. by microencapsulating by extrusion.

Based on the electronic nose analyses data it can be seen that microencapsulation has different effects on the intensity of the volatile aroma. All the tested samples had a different behaviour in terms of the aroma binding and release. The samples P6 and P11 with 17.54% respectively 12.51% moisture content were the most effective in binding the flavour. It can be concluded that β-cyclodextrin is very powerful in protecting the cinnamon aroma, by trapping it in the microcapsule. The moisture percentage had a very less influenceas as very small differences between the two samples were observed.

By the electronic nose analyses. the samples were separated very clearly and applying PCA procedure a high discrimination index (of 92 out of 100) value was achieved.

Further experiments will be made to see how storage conditions and time will affect the binding process and the aroma intensity in the control and microencapsulated samples on the gluten-free production technological flow.

Analitycal methods as GC-MS will be imply to correlate the data from the electronic nose [1, 25].

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