ACTA TECHNICA CORVINIENSIS
BULLETIN OF ENGINEERING

[1.] CLAUDIU URSACHI, [2.] RODICA SEGAL , [3] CLAUDIA MURESAN

VACUUM IMPREGNATION PRETREATMENT OF FRESH CUT VEGETABLE

Abstract:
Vegetal products are generally characterized through a high level of sensitivity due to environmental factors and to the operations they are submitted to during their preparation. This leads to meaningful changes regarding vegetal products nutritional and sensorial characteristics. The prevention of such drawbacks can be made by introducing active compounds in their structure in order to protect them from unwanted alterations. The introduction of compounds can be achieved through classical infusion, through the immersion of the products in hypertonic solutions of the respective compound, or through a new technology, vacuum impregnation. In this paper, we present the data obtained during the experiments regarding impregnation whit some nutraceutical under a 500 mbarr vacuum of some vegetables, evaluated through physical and chemical proprieties.

Keywords:
vegetal products, environmental factors, pretreatment, fresh cut vegetable

INTRODUCTION

The increasing interest of people for the consumption of foods that have a beneficial effect on health has oriented both the research and the production in food industry towards the goal of obtaining such products[1]. Due to this fact, one of the main directions in the alimentary industry is focused upon the preservation of the existing natural compounds either through the minimum processing of the raw materials or through the strengthening of the foods with multiple physiologic active compounds such as prebiotics, probiotics, vitamins, fiber, mineral salts etc[2].
Another possibility to introduce the compounds in the structure of vegetable products, especially in the internal structure of fruit and vegetables, consists in the usage of a new technology, vacuum impregnation.

Vacuum impregnation consists in the immersion of vegetable products, characterized through high porosity (apple, quince, strawberries, apricots, peaches, peppers, mushrooms, etc), in solutions which contain dissolved substances meant to impregnate the product, followed by their storage in a place under a certain void pressure[3]. This technology can be applied in order to better the texture of the product to reduce its level of oxidation and its exudates at defrosting, to maintain its color, and to strengthen the different vegetable products with all kinds of nutrients: vitamin E[4], minerals salts like Ca and Zn[5], probiotics[6].
The aim of this paper is to use vacuum impregnation in order to introduce ascorbic acid into the structure of apples, so that the products become strengthened with vitamins and follow the vitamin's stability during the storage of apples in terms of refrigeration and defrosting[7]. We also took into account the need to prevent

the sliced apples to turn brown during this process, knowing their sensitivity towards oxidative factors on the one hand and the antioxidant properties of ascorbic acid[8] on the other hand.

THE STUDY

Materials and methods

Golden Delicious apple were purchased from a local store.

The following instrumentation has been used: installation for impregnation under void which consists in a RL-2 void pump and a vacuum-meter - manufactured by REFCO Manufacturing Ltd. from Switzerland- linked to a void exicator.

For impregnation we used a 0.5 per cent ascorbic acid (Fluka CH 9470 Buchs) solution.

The dosage of vitamin C was realized by iodomethric method[9], using solutions of potassium iodide 1 per cent and potassium iodate n/1000.

Experimental

The healthiest products have been chosen for the experiments, they were washed, their seeds and the seed home were removed with an stainless tubular knife and afterwards they were pealed off and cut in round shapes with the help of an stainless knife. The round circles had between 7 and 10 mm and a mass between 11 and 13.5 g. The samples were immersed in a solution in order to avoid their contact with the the air, apples sensitivity towards oxidation being a well known feature.

For impregnation we used a 0.5 per cent ascorbic acid solution.

For impregnation at atmospheric pressure, the apple slices were immersed within the solution. When the time expired, the apples have been removed from the ascorbic acid solution, they were put on a filter paper in order to obviate excessive water. One of the samples was used in order to dosage the vitamin C, while three other samples have been placed in glass containers and stored in the absence of light under refrigeration at 4 0C. Vitamin C has been dosed after three, six and nine days.

Two samples were kept under refrigeration at -180C. In this case, the dosage of vitamin C was done after 9 and 14 days.

For vacuum impregnation, the apple slices were immersed in the solution, introduced in the void exicator and maintained at a 500 mbarr vacuum pressure for 10 minutes. When the time expired, the apples have been removed from the solution; they were put on a filter paper in order to obviate excessive water. We calculated the quantity of impregnated solution and expressed it in percentage. A sample was used immediately for determination of vitamin C and three samples were placed in glass containers and stored in the absence of light under refrigeration at 4 0C. Vitamin C was dosed after three, six and nine days.

Two samples were stored in a freezer at -18^{0}C. In this case, the dosage of vitamin C was done after 9, and 14 days. The dosage of vitamin C was done using an iodomethric method. The method was chosen because it is simple and quick, it can be used for uncolored products, if we want to do some tests in order to obtain comparative results for products of the same species. The method is based on ascorbic acid oxidation with iodine produced through a reaction between potassium iodide and potassium iodate in an acid environment.

From an average sample made of examined material 10-20g is taken. The weighing are done using a analytical balance. The weighted material is grinded in a mortar with a bit of hydrochloric acid 2 per cent and 5 d of quartz sand, until a homogeneous paste is obtained. 40-50 ml dilution of hydrochloric acid 2 per cent is added and after a short mixing it is left to settle aut for e few minutes, then is filtered in a measuring bottle of 100 cm^3. The material remained in the mortar is washed 3-4 times with hydrochloric acid 2 per cent levigating and filtering the dilution and washing the measuring botlle. Thenceforth it is brought to the sign with hydrochloric acid 2 per cent and strongky stirred.

In an Erlenmayer of 100 cm^3, 10 cm^3 of the obtained extract is instilled, 30 cm^3 of distilled water, 5 cm^3 of potassium iodide 1 per cent and 5 cm^3 of starch glue 0,2 per cent as an indicator are added. It is titrated using potassium iodate n/1000 up to dark blue persistent 30 seconds.

The calculation results:

$$VitaminaC = \frac{V \times V_1 \times 0{,}088}{G \times V_2} \times 100$$

where: V - potassium iodate volume n/1000 for titrating [cm³];
V_1 - extract volume [cm³];
V_2 - semples volume [cm³];
G - weight of the analyzed sample [g];
Each measurement was taken in duplicate.

ANALISES, DISCUSION, APROACHES, INTERPRETATIONS

The results which were obtained after the dosage of ascorbic acid for the analyzed samples are listed in Table 1 and Table 2.

Table1. The content of vitamin C in the apples impregnated with a solution of ascorbic acid 0.5 per cent at atmospheric pressure and under vacuum after the preservation under refrigeration.

Nr. crt.	Sample	Vitamin C content [mg/100g product]			
		T_0	T_1	T_2	T_3
1.	Control	6,47	3,92	-	-
2.	Sample impregnated at atmospheric pressure and refrigeration	36,03	12,09	8,55	5,92
3.	Sample impregnated under vacuum and refrigeration	81,46	73,05	62,41	37,26

T_0 = immediately after impregnation,
T_1 = 3 days, T_2= 6 days =, T_3 = 9 days

Table 2 The content of vitamin C in the apples impregnated with a solution of ascorbic acid 0.5% at atmospheric pressure and under vacuum after the preservation under freezing.

Nr. crt.	Sample	Vitamin C content [mg/100g product]		
		T_0	T_4	T_5
1.	Sample impregnated at atmospheric pressure and freezing	37,29	31,42	30,45
2.	Sample impregnated under vacuum and freezing	79,84	72,96	72,47

T_0 = immediately after impregnation,
T_4 = 9 days, T_5 = 14 days

This study shows that by the vacuum impregnation of apples, Figure 1 (in certain work conditions) the content of ascorbic acid can be increased by 55% compared to the atmospheric pressure impregnation.
A reduction of ascorbic acid degradation has also been observed regarding the samples which had been impregnated under vacuum, compared to samples impregnated at atmospheric pressure, in the cases of preservation under refrigeration as well as the preservation in freezing conditions. Thus:

- *after 3 days the sample impregnated under vacuum reduced its content of vitamin C by only 10.32% while the sample impregnated at atmospheric pressure reduced its Vitamin C content with 33.5%;*
- *after 6 days the sample impregnated under vacuum reduced its content of vitamin C by only 23.38% while the sample impregnated at atmospheric pressure reduced its Vitamin C content with 76.27%;*
- *after 9 days the sample impregnated under vacuum reduced its content of vitamin C by 54.26% while the sample impregnated at atmospheric pressure reduced its Vitamin C content with 83.56%;*

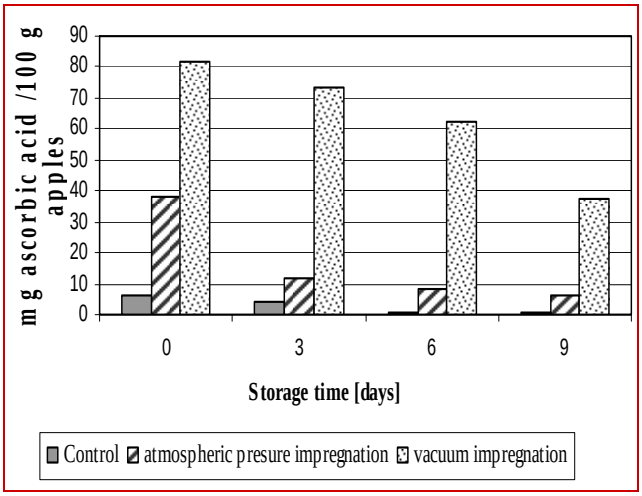

Fig. 1. Vitamin C content in fresh cut apples after refrigeration

The growth of ascorbic acid content and its higher stability can be explained by the fact that under vacuum impregnation the ascorbic acid penetrates into the plant tissue replacing the air (oxygen) from the apples porous structure.

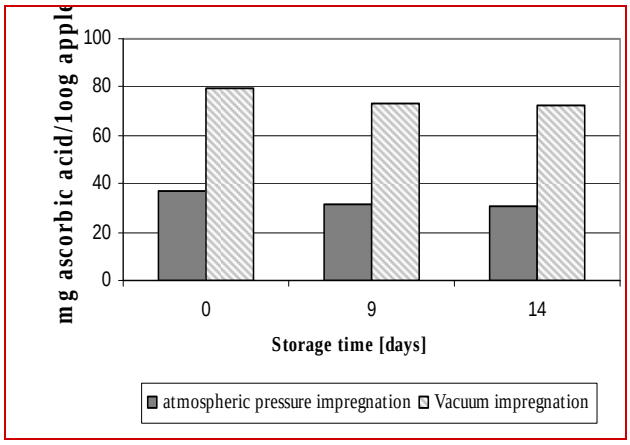

Fig. 2. Vitamin C content in fresh cut apples after freezing

By keeping products in frozen state, as was expected, the stability of vitamin C is higher (Figure2) than by preserving the products refrigerated. Nevertheless in this case the vacuum impregnation content of vitamin C was reduced by only 8.61% after 9 days and 9.22 after 14 days, in comparison to impregnation at atmospheric pressure where the reduction was of 15.7% after 9 days, respectively with 18.34 after 14 days.

CONCLUSION

Vacuum impregnation allows the ascorbic acid to incorporate itself in the structure of the apples in a much higher quantity than under atmospheric pressure. At the same time, vitamin C, impregnated under vacuum, has a greater stability in time due to the absence of oxygen.
Impregnation under vacuum thus presents a great potential of strengthening porous plants with other nutrients intended to improve their nutritional characteristics and also with compounds that can have a positive effect upon their physical or sensorial characteristics.
The sensorial evaluation of products impregnated under vacuum is particularly important in order to observe their degree of acceptance by consumers, task with which we shall continue these studies.

REFERENCES

[1] *E. A.SLOAN: The top ten functional food trends: the next generation, Food Technology, 56, 32-57,(2002).*
[2] *R. SEGAL, G.M. COSTIN: Alimente funcţionale, Editura Academica, Galaţi, Romania, 307-309, (1999),*
[3] *A. CHIRALT, P. FITO, A. ANDRES, J. BARAT: Vacuum impregnation: a tool in minimally processing of foods. Processing of foods quality, optimization and process assessment, CRC Press, 341-356, (1999).*
[4] *S. PARK, Z. YHAO, S. LEONARD, M.G. RABER: Vitamin E and mineral fortification in fresh-cut apples (Fuji) using vacuum impregnation, Nutrition, and Food Science, 35(6), 393-402,(2005)*
[5] *J.XIE, Y. ZHAO: Nutritional enrichment of fresh apple (Royal Gala) by vacuum impregnation. International Journal of Food Science and Nutrition, 54 (5), 387-398, (2003).*
[6] *N. BETORET, L. PUENTE, M.J. DIAZ:. Development of probiotic-enriched dried fruits by vacuum impregnation. J. of Food Engineering, 56, 273-277, (2002).*
[7] *J.XIE, Y. ZHAO: Practice application of vacuum impregnation technology in fruit and vegetable processing. Trends in Food Science and Technology, (15), 9, 434-451,(2004).*
[8] *D. SALVATORI, D. ANDRES, A. CHIRALT, P. FITO: The response of some proprieties of fruits to vacuum impregnation, J. of Food Process Engineering, 21, 59-73, (1999)*
[9] *A.A. IZUGAIE, F.O. IZUAGIE: Iodometric Determination of Ascorbic Acid (Vitamin C) in Citrus Fruits. Research Journal of Agriculture and Biological Sciences, 3(5)*

AUTHORS & AFFILIATION

[1.] CLAUDIU URSACHI,
[2.] RODICA SEGAL ,
[3] CLAUDIA MURESAN

[1.,3.] DEPARTMENT OF TECHNICAL SCIENCE AND TECHNOLOGY, "AUREL VLAICU" UNIVERSITY OF ARAD,
[2.] FACULTY OF FOOD SCIENCE AND ENGINEERING , "DUNAREA DE JOS" UNIVERSITY OF GALATI, ROMANIA