



## SOME CHEMICAL ASPECTS DURING WHITE CABBAGE PICKLING PROCESS

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**Abstract.** *In this work was searched the evolution of some chemical parameters (salt content, pH and ascorbic acid content) during cabbage pickling. The biological material was white cabbage purchased from commercial network, iodized and non-iodized salt and water. In various glass jars were introduced different samples of cabbage (whole and minced), over which was poured brine (iodized and non-iodized salt), for each type of cabbage. The samples were left to ferment, and at 3-4 days were made determinations of salt content, ascorbic acid and pH. During pickling, the evolution of both types of salt (iodized and iodized), accumulated both in the whole and in the minced cabbage, showed a progressive increase in the first 5-8 days, after which the values decreased, reaching minimum, in all cases, at 26 days of pickling. Throughout the trial, in both types of cabbage (whole and chopped) non-iodized salt was accumulated in larger quantities than iodized one. For the both types of cabbage, the pH of sauce, obtained with iodized salt, recorded greater reductions than the pH of sauce with non-iodized salt. The higher pH values were recorded in the sauce derived from whole cabbage. During pickling process, the biggest losses of ascorbic acid were recorded in minced cabbage, whose brine was prepared with iodized salt. The evolution of the ascorbic acid concentration in the two types of cabbage sauce highlights, in all cases, greater increases in chopped cabbage brine, processed with iodized salt.*

**Keywords:** cabbage, salt, sauce, pickling, ascorbic acid, pH

### 1. Introduction

For the human diet, vegetables and fruits are fundamental sources of water-soluble vitamins (vitamin C and group B vitamins), provitamin A, phytosterols, dietary fibres, minerals and phytochemicals [1 cited by 8]. According to some authors [2, 3], cooking, pasteurization and the addition of chemical preservatives are the main technology options guaranting vegetables and fruits safe, but bringing a number of (not always) desirable changes in their physical characteristics and chemical composition. In order to preserve vegetables and fruits for a long time without modifying their properties, there were developed some conservation methods based on growth of

lactic acid bacteria from microbiota of these plant species over other existing organisms. This preservation methods are known as: acidification or pickling methods. Lactic acid fermentation is considered as the simple and valuable biotechnology to keep and/or enhance the safety, nutritional, sensory and shelf life properties of vegetables and fruits [4, 5, 6, 7, 8]. Lactic acid fermentation undoubtedly represents the easiest and the most suitable way for increasing the daily consumption of fresh-like vegetables and fruits [8]. Some fermented pickles, such as: seasonal leafy vegetables, radish, cucumbers and young tender bamboo shoots, obtained through indigenous techniques of bio-

preservation, are very popular in Asian and African countries, representing fundamental components of their daily diet [9].

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There are many scientific works describing the lactic acid fermentation of cabbage to get sauerkrauts and of olives to make table olives [10].

## 2. Experimental

### 2.1. Research materials

In this paper, the biological material was white cabbage purchased from commercial network, selected to meet the quality parameters necessary to conservation. The cabbage was fresh, well made, no damage and no attack by insects or parasites, clean, odorless and taste, with a head weight of between 1-1.5 kg. Fresh raw material (prior to curing by pickling) was analyzed, determining the pH, whose value was **6.94**, and the content of ascorbic acid (**36.21 mg %**).

For experiments it used iodized and non-iodized salt recrystallized and water from the distribution network of the Suceava city. The salt used was provided by the National Salt Company, Salina Cacica Branch.

### 2.2. The preparation of pickles

*Whole cabbages* were clean and were placed in two jars of colored glass, of 15 liters each, well stuffed (pressure) do not run goals. Using the two types of salt (iodized and non-

In Romania, pickles (cucumbers, cabbage, cauliflower, carrots, green tomatoes, fruits) are very popular and appreciated, being consumed especially in winter. Of these, pickled white cabbage is, for many families, a component of the daily diet (spice and / or food), being almost customary in the diet. In this work was studied the evolution of some chemical parameters (salt content, pH and ascorbic acid content) during pickling of whole and minced white cabbage, using two types of brine: iodized and non-iodized salt.

iodized) there were prepared in 2 pots, two types of brine, introducing of 45 g salt per liter of water. Among the rows of cabbage there were placed pieces of horseradish root and flourished over dill and dried, because after Banu et al. (2000) the additions improved the flavor of the product and the respective broth with preservative role. Before closing the jars, there were placed two small wooden boards (cross) to prevent cabbage to rise above, then the jars were left to ferment at 15-18°C. For anaerobic environment may favor butyric fermentation, the cabbage brine was subjected to periodic aeration [12], through introduction of the air into the brine by means of a hose or by pouring from one container to another in prolonged contact with air. After completion of pickling tank, pickled cabbage was stored at 8-10°C. *Minced cabbage* was obtained from fresh cabbage, healthy, clean, without outer leaves, which was cut with a knife steel in long thin strips.

The cabbage fragments were transferred within two metal flasks and were salted, separately, with iodized and non-iodized salt (25-30 g of salt per 1 kg of cabbage), and then were rubbed for leaving enough juice.

After approx. 30-60 minutes, the shredded and salt cabbage from containers was introduced in two jars of colored glass (5 liters each), one for each type of salt, squeezed by hand as well to cover the cabbage with soup made (2-3 cm liquid). Above they have put a few celery leaves for flavor and two small wooden boards cross. The initial fermentation temperature was 18-

20°C for 3 days, after which the jars were transferred to a room at a temperature of 8-10°C. During fermentation it was added brine, made up of 15 g of salt per liter of water. The determinations of chemical and biochemical parameters were carried out to each 3-4 days, using the whole or chopped pieces of cabbage or brine, in both types.

### 2.3. Research methods

The evaluations of the three parameters (salt concentration, pH and concentration of ascorbic acid) were made at specific intervals (2, 3 or 4 days), the first measurement being every three days from the beginning of the pickling process.

**Determination of salt (NaCl) concentration** was made from pickled products, by titrimetric method, based on sodium chloride titration with silver nitrate in the presence of potassium chromate as indicator. The result was expressed in grams

of sodium chloride in 100 g (100 ml) of product [13].

**Determination of pH** was made with a digital pH meter supplied by Hanna Instruments.

**Determination of ascorbic acid** was made from products and its sauce according to official AOAC methods [14], based on the reduction by ascorbic acid of 2,6-Dichlorophenol-indophenol (2,6-DCFIF) to the corresponding leucoderivate. The result was expressed as mg ascorbic acid per 100 g (100 ml) of product.

### 3. Results and discussion

In Fig. 1 is shown the evolution of the salt concentrations (iodized and non-iodized) of the cabbage samples. Evolution of salt accumulated in whole cabbage during

pickling showed a progressive increase of this parameter, which reached a maximum after eight days for both types of salt: 2.48 g NaCl/100g of product for non-iodized salt and 2.19 g NaCl/100g of product for iodized salt.

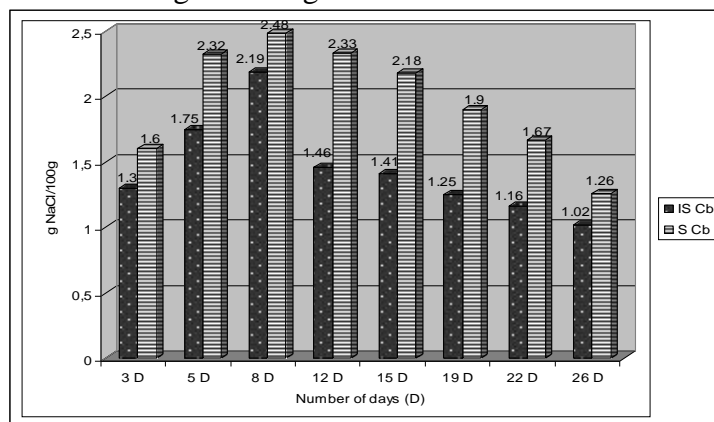
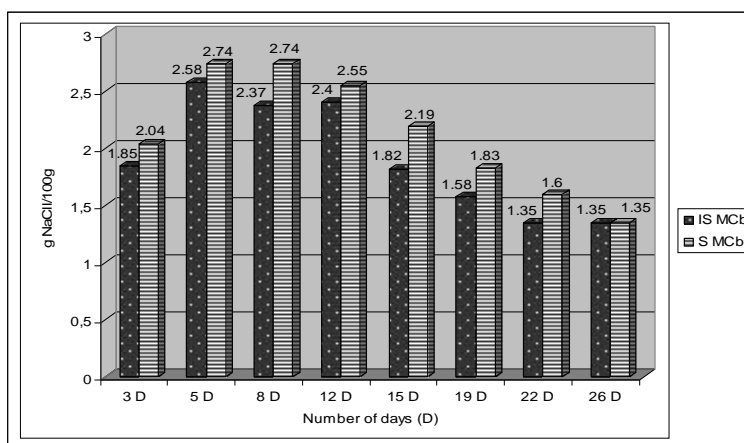


Fig. 1. The evolution of the salt values in whole cabbage during pickling process  
IS Cb = iodized salt in cabbage; S Cb = non-iodized salt in cabbage

Further, since the 12th day, both types of salt concentration values were decreased with time, reaching a minimum after 26 days (1.26 g NaCl/100g of product for non-iodized salt and 1.02 g NaCl/100g of product for iodized salt). At all periods examined, the highest values were recorded for iodized salt.

In the Fig. 2 are reproduced the salt concentration values acquired in minced

cabbage during pickling. As seen, in minced cabbage the concentration of the both salt types reached maximum values after five days of pickling (2.74 g NaCl/100g of product for non-iodized salt and 2.58 g NaCl/100g of product for iodized salt). The concentration of both types of salt decreased, to finally reach the same amount (1.35 g NaCl/100g of product).



**Fig. 2. The evolution of the salt values in minced cabbage during pickling process**  
IS MCb = iodized salt in minced cabbage; S MCb = non-iodized salt in minced cabbage

Throughout the process of pickling, the iodized salt was accumulated in the largest quantities in minced cabbage. In the whole cabbage, the iodized salt concentration has The non-iodized salt has accumulated in higher quantities in chopped cabbage samples, only in the range 3-12 days of The greater amount of salt (iodized and non-iodized) acquired into minced cabbage, compared to the whole cabbage, can be explained by the grinding process, which, on the one hand, increases the area of contact between the cells and brine, and on the other side, destroys many cells facilitating the easier ingress of salt in the tissues fragments of cabbage.

According to Banu et al. (2003), the lactic fermented foods (pickled cabbage, pickled

an evolution with similar values of chopped cabbage, especially in the second part of the pickling period (15-26 days).

pickling. Next 15-26 days, the concentration values of non-iodized salt were very close in the both types of pickled cabbage.

cucumbers) partial loss nutrients and biominerals of raw materials, passing the liquid (fermentation broth). This may explain the progressive decrease of the amount of salt in cabbage during pickling process in this experiment.

The pH of the two samples (whole and minced cabbage) has changed during pickling, registering, in all cases, cut-off, larger or smaller, depending on the type of salt used and the analysed interval (Table 1).

**Table 1** The pH values of cabbage sauce during pickling process

Number of days (D)	3 D	5 D	8 D	12 D	15 D	19 D	22 D	26 D
<b>Samples</b>	<b>pH</b>							
Cabbage sauce with iodized salt	6.75	6.67	6.07	4.51	4.10	4.02	3.97	3.87
Cabbage sauce with non-iodized salt	6.68	6.45	5.40	4.49	4.15	3.95	3.98	4.15
Minced cabbage sauce with iodized salt	6.13	6.07	4.66	3.90	3.77	3.80	3.81	3.95
Minced cabbage sauce with non-iodized salt	6.00	5.47	4.71	4.10	3.95	3.92	3.96	3.99

From the Table 1 it can see that the pH of cabbage sauce, with iodized salt, showed (after 26 days) the largest decreases: 3.07 units for whole cabbage and 2.99 units for minced one, versus 2.53 units for whole cabbage, and 2.01 units for minced cabbage, in non-iodized salt sauce. For both types of salt, the broth (sauce) acidification was more pronounced in the first 15 days of the pickling process.

The comparative evolution of pH values during pickling process of whole and chopped cabbage samples (with iodized and non-iodized salt) showed that the highest pH values were recorded in the sauce derived from whole cabbage.

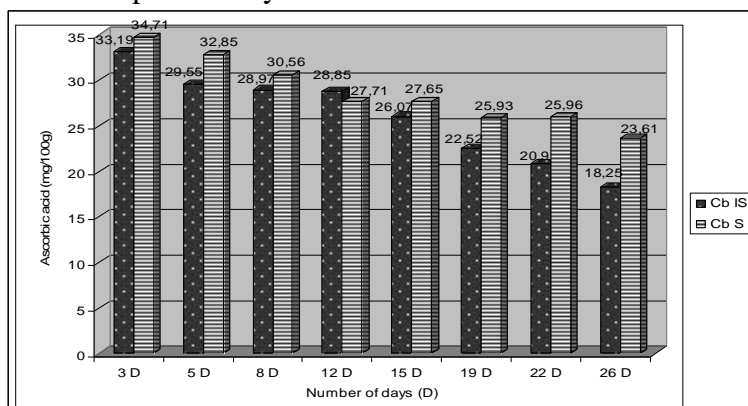
The stronger acidification of the broth from minced cabbage, compared to broth from whole cabbage, can be explained by the

greater amount of nutrients released from damaged cells through grinding, resulting in increased fermentative activity of the microflora present in the environment, which produces a larger amount of lactic acid.

Fig. 3-4 show the ascorbic acid values in the cabbage samples during pickling.

In whole cabbage, after 26 days from the beginning of the pickling process, the content of ascorbic acid was reduced by 49.6% in cabbage with iodized salt, and by 34.8% in cabbage with non-iodized salt (Fig. 3).

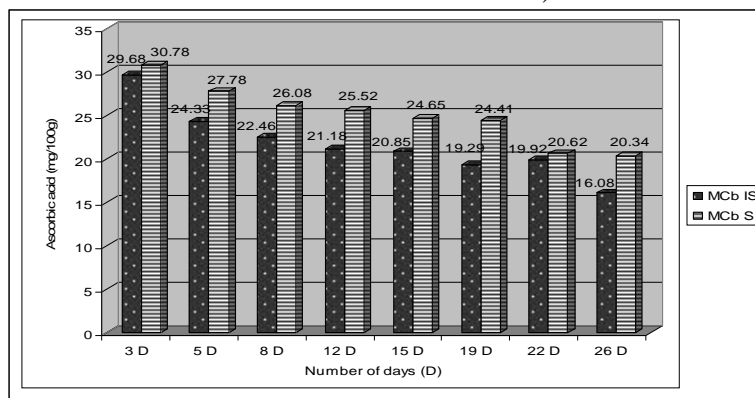
In whole cabbage, the highest percentage reduction of ascorbic acid were recorded in the first 19 days of pickling (by 37.8% in cabbage with iodized salt, and by 28.39% in cabbage with non-iodized salt).



**Fig. 3.** The ascorbic acid evolution in cabbage during pickling process  
Cb IS = cabbage in iodized salt; Cb S = cabbage in non-iodized salt

In minced cabbage, after 26 days of pickling, the ascorbic acid content decreased by 55.6% in cabbage with iodized salt, and by 43.85% in cabbage with non-iodized salt (Fig. 4).

At minced cabbage, the highest percentage reduction of ascorbic acid were recorded in the first 15 days of pickling (by 42.4% in chopped cabbage with iodized salt, and by 31.9% in chopped cabbage with non-iodized salt)



**Fig. 4. The ascorbic acid evolution in minced cabbage during pickling process**  
MCb IS = minced cabbage in iodized salt; MCb S = minced cabbage in non-iodized salt

Through analysis of ascorbic acid evolution during pickling of the two types of cabbage, it results that the highest values of this parameter were recorded in the samples with non-iodized salt.

For the both types of salt, throughout the study (26 days) the highest values of ascorbic acid were recorded in the whole cabbage. One explanation may be that, during shredding, the cabbage loses, by oxidation, some of ascorbic acid (vit. C). The sauce of the pickled products evidenced different levels of ascorbic acid, depending

process continued, perhaps, with a lower intensity throughout the pickling.

According to Banu et al. (2003), simply cut of cabbage, carrots leads to losses of up to 75% for vitamin C. Also, iodine in the salt composition probably contributed to the degradation of this vitamin, because in all samples analyzed and at all intervals the ascorbic acid concentration was lower when using iodized salt, as compared with non-iodized salt.

on the type of salt and the characteristics of the biological material used (Table 2).

**Table 2 The ascorbic acid values in cabbage sauce during pickling process**

Number of days (D)	3 D	5 D	8 D	12 D	15 D	19 D	22 D	26 D
<b>Samples</b>	<b>Ascorbic acid (mg/100 g)</b>							
Cabbage sauce with iodized salt	7.92	8.81	11.48	13.06	13.86	13.88	15.04	16.63
Cabbage sauce with non-iodized salt	7.31	8.33	10.29	11.06	11.84	12.37	12.74	13.02
Minced cabbage sauce with iodized salt	8.71	11.27	12.65	14.44	14.61	15.44	15.94	16.76
Minced cabbage sauce with non-iodized salt	7.92	10.84	11.85	12.30	12.78	13.30	13.90	14.04

As seen in the Table 2, in the whole cabbage sauce, pickled in iodized salt, the ascorbic-

acid content has increased by 105% (from the first to the last determination), while in

sauce pickled in non-iodized salt the ascorbic acid content has increased by 89%. Also, in the Table 2 can be seen that ascorbic acid in the sauce of minced cabbage, processed with iodized salt, recorded, after 23 days, an increase of ascorbic acid values by 96.2%, and in the sauce of minced cabbage, processed with non-iodized salt, an increase by 88.64%. There were calculated the simple correlations between pH and ascorbic acid values in the cabbage samples and its sauce, during pickling process with non-iodized salt, because the lowest losses of ascorbic acid were found in pickled samples with this type of salt. If in the samples of cabbage

#### 4. Conclusions

The analysis of salt content, the pH values and the ascorbic acid content of in the samples of white cabbage (whole and cubed) during pickling with iodized and non-iodized salt, some differences were found between samples, depending on the type of cabbage and type of salt used.

During pickling, the evolution of both types of salt (iodized and iodized), accumulated both in the whole and in the minced cabbage, showed a progressive increase of this parameter up to the maximum values at 8 and 5 days, after which the values decreased, reaching minimum, in all cases, at 26 days of pickling. Throughout the trial, in both types of cabbage (whole and

From the data of Table 2 results that ascorbic acid concentration recorded, in all cases, higher increases in pickles sauce processed with iodized salt, which shows that higher vitamin losses from these samples are partially found in the sauce of these pickles. In the both types of salts, the highest increases of ascorbic acid were in the sauce derived from minced cabbage. (whole or minced) between pH values and ascorbic acid content not significant correlations could be established, in sauce samples were negative correlations more significant in the samples from the whole cabbage ( $R^2=0.9522$ ).

chopped) non-iodized salt was accumulated in larger quantities than iodized one.

For the both types of cabbage, the pH of sauce, obtained with iodized salt, recorded (during pickling) greater reductions than the pH of sauce with non-iodized salt. The higher pH values were recorded in the sauce derived from whole cabbage.

During pickling, the biggest losses of ascorbic acid were recorded in minced cabbage, whose brine was prepared with iodized salt. The evolution of the ascorbic acid concentration in the two types of cabbage sauce highlights, in all cases, greater increases in chopped cabbage brine, processed with iodized salt.

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