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THE STABILITY OF VITAMIN C IN MODEL SALADS PREPARED FROM TOMATOES WITH FRESH CUCUMBER®

Stabilność witaminy C w modelowych sałatkach przygotowanych z pomidorów z dodatkiem świeżego ogórka zielonego®

Celem artykułu jest prezentacja uzyskanych wyników badań dotyczących stabilności wit. C w modelowych sałatkach sporządzonych z pomidorów bez dodatku oraz z dodatkiem świeżego ogórka zielonego, zawierającego enzym askorbinazę, który rozkłada wit. C. Zawartość wit. C oznaczano metodą Tillmansa w surowcach po obróbce wstępnej (myciu i rozdrabnianiu) oraz w modelowych sałatkach przechowywanych w temp. 10°C, w czasie 2, 4 i 24 godz. Stwierdzono, że obróbka wstępna świeżych pomidorów i ogórków (mycie i rozdrabnianie) powoduje straty wit. C w ilości odpowiednio 20,7 i 37,4%, a wymieszanie tych surowców w stosunku 1:1 dodatkowo zwiększa straty tej witaminy o kolejne 25–40%. Straty wit, C po 2 godz. przechowywania sałatki pomidorowo-ogórkowej wynosiły ponad 50% wobec 12,7% strat tej witaminy z rozdrobnionego pomidora bez dodatku ogórka. Po 24-godzinnym przechowywaniu modelowych sałatek straty te wzrosły do ponad 80% (z udziałem ogórka) lub poniżej 65% (bez udziału ogórka świeżego). Większe straty wit. C z sałatki z udziałem świeżego ogórka wynikały z enzymatycznego oddziaływania obecnej w nim askorbinazy.

Słowa kluczowe – sałatki, pomidor, ogórek świeży, przechowywanie, zawartość i straty wit. C.

The aim of the article is to present the results of research on the stability of vitamin C in model prepared from tomatoes without the addition and with the addition of fresh green cucumber, containing the ascorbinase enzyme, which breaks down vit. C. The contents of vitamin C was determined by the Tillmans method in raw materials after pre-processing (washing and shredding) and in model salads stored at 10°C for 2, 4 and 24 hours. It was determined that pre-treatment of fresh tomatoes and cucumbers (washing and shredding) causes loss of vit. C in amounts of 20.7 and 37.4%, respectively, and mixing these raw materials in the 1:1 ratio additionally increases the loss of this vitamin by another 25–40%. Losses of vit. C after 2 hours of storing the tomato-cucumber salad was over 50%, compared to the 12.7% loss of this vitamin from a fragmented tomato without the addition of cucumber. After 24-hour storage of model salads, these losses increased to over 80% (with cucumber) or below 65% (without fresh cucumber). Greater losses of vit. C from salad with the share of fresh cucumber resulted from the enzymatic impact of ascorbinase present in it.

Key words – salads, tomato, fresh cucumber, storage, vitamin C content and loss.

INTRODUCTION

One of the important aspects for preserving health and proper functioning of the human body is the adequate supply of vitamins [2]. Special attention should be given to vitamin C, which, according to the amended nutrition standards for the Polish population, is defined as *„a water-soluble organic compound with strong reducing properties"* [8].

Vitamin C is an unstable substance, which is water-soluble, sensitive to light, oxygen, increased temperature or the presence of catalysts. It is easily decomposed in an alkaline or neutral environment. However, it is relatively stable in the range of pH 4–6 [7, 11]. Loss of vitamin from food can be caused by improper storage, processing or inadequate selection of raw materials [2, 11]. During storage, L-ascorbic acid is oxidised to dehydroascorbic acid, which in further transformations undergoes irreversible hydrolysis to 2,3-dioxo-L-gulonic acid, which lacks vitamin activity [3].

It is known that the best source of vitamin C are fruit and vegetables, which is why attention is paid to frequent consumption in various forms, most often in a raw or in low-processed form, e.g. as salads [9, 14]. It is recommended to eat at least 4 portions of vegetables and 3 portions of fruit during the day [8].

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In accordance with the principles of good technological practice, salads made of fresh fruit and vegetables should be prepared at least 30 minutes before serving and should be stored in refrigerated conditions. Nevertheless, at home, these recommendations are often not followed, and the literature does not provide detailed data on the loss of vitamins during storage of salads for the period longer than 30 minutes.

The objective of the study was to examine the stability of vitamin C in model salads made of tomatoes and tomatoes with fresh green cucumber containing the ascorbase enzyme, which breaks down vitamin C.

MATERIAL AND METHODS

The study material consisted of plum tomatoes (Caniles variety) and fresh, long trellis cucumber of the Atar variety from market purchases. The model tomato and cucumber salad was prepared by mixing fragmented raw materials (into particles of the same size constituting 2 cm x 0.5 cm strips) in a 1:1 weight ratio. The prepared salad and shredded single raw materials were stored for 2, 4 and 24 hours at +10°C.

The content of vitamin C was determined by the Tillmans method, in accordance with Polish Standard PN-A-04019 [13]. Vitamin C losses were calculated mathematically, taking into account the initial (100%) and final content of this vitamin in raw materials and prepared salad. The results were statistically analysed by calculating the average and standard deviation.

RESULTS

Fresh, unshredded tomato contains 18.55 mg of vitamin C in 100 g, whereas a shredded tomato contains 20.7% less, i.e. 14.72 mg. Cucumber, usually with the low content of vitamin C (4.32 mg/100g), as a result of shredding loses 37.4% of its initial content (Table 1).

Table 1. Losses and content of vit. C in tomatoes and cucumbers before and after grinding

Tabela 1. Straty i zawartość wit. C w pomidorach i ogórkach przed i po rozdrobnieniu

Type of raw material / Rodzaj Surowca	Vitamin C content in mg/100 g (x̄śr ± SD) / Zawartość witaminy C w mg/100 g (x̄śr ± SD)		Loss of vit. C [%] / Straty wit. C [%]
	before comminution / przed rozdrobnieniem	after crushing / po rozdrobnieniu	
Tomato / Pomidor	18,55 ± 0,15	14,72 ± 0,60	20,7
Fresh cucumber / ogórek	4,32 ± 0,44	2,70 ± 0,14	37,4

Source: Own study

Źródło: Badania własne

By mixing shredded tomatoes and cucumbers in a 1:1 weight ratio, after approx. 15 minutes the amount of vitamin C contained in shredded raw materials was reduced by 62.4% (Table 2).

Table 2. Losses and content of vit. C in tomato and cucumber salad before and after mixing

Tabela 2. Straty i zawartość wit. C w sałatce pomidorowo-ogórkowej przed i po mieszaniu

Type of raw material / Rodzaj Surowca	Vitamin C content in mg/100 g (x̄śr ± SD) / Zawartość witaminy C w mg/100 g (x̄śr ± SD)		Loss of vit. C [%] / Straty wit. C [%]
	before mixing (average value) / przed mieszaniem (wartość średnia)	after mixing / po wymieszaniu	
Tomato + Fresh cucumber (1:1) / Pomidor + ogórek (1:1)	8,71 ± 0,20	5,44 ± 0,24	62,4

Source: Own study

Źródło: Badania własne

In Table 3, the content of vitamin C in a model tomato and cucumber salad and individual shredded raw materials stored at different times was shown. While in Fig. 1 the losses of vit. C that occurred during the storage of a model tomato and cucumber salad and single shredded ingredients were compared. These losses were increasing over the increasing storage time.

Table 3. Loss and vitamin C content in salad and individual raw materials during storage

Tabela 3. Straty i zawartość witaminy C w sałatce oraz pojedynczych surowcach podczas przechowywania

Storage time [h] / Czas przechowywania [godz.]	Vitamin C content in mg/100 g (x̄śr ± SD) Zawartość witaminy C w mg/100 g (x̄śr ± SD)		
	Tomato and cucumber salad / Sałatka pomidorowo-ogórkowa	Tomato salad – shredded tomato without the addition of cucumber / Sałatka pomidorowa – rozdrobniony pomidor bez dodatku ogórka	Shredded cucumber Rozdrobniony ogórek
0 (kontrolna)	5,44 ± 0,24	14,72 ± 0,60	2,70 ± 0,14
2	2,63 ± 0,05	12,85 ± 0,01	1,25 ± 0,07
4	1,86 ± 0,20	10,26 ± 0,01	0,71 ± 0,09
24	0,90 ± 0,09	8,95 ± 0,003	0,15 ± 0,02

Source: Own study

Źródło: Badania własne

Vitamin C was relatively stable during storage of shredded tomatoes. After 2 hours, tomatoes lost 30.3% of their original content of vitamin C and 30.3% after 4 hours. After 24-hour-long storage, the shredded tomatoes retained nearly 60% of the initial content of vit. (Fig. 1).

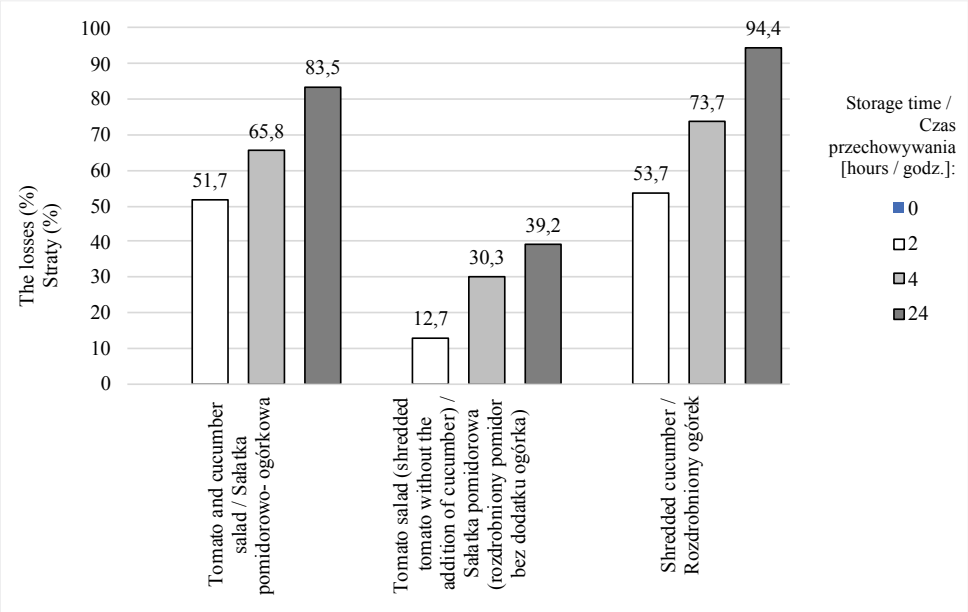

Fig. 1. Comparison of vitamin C losses from a model tomato-cucumber salad and individual salad ingredients.

Rys. 1. Porównanie strat wit C z modelowej sałatki pomidorowo-ogórkowej i pojedynczych składników sałatki.

Source: The own study

Źródło: Badania własne

Shredded cucumber lost the most of vit. C: over 50% of the original content after 2 hours, almost 75% after 4 hours and over 94% after 24-hour storage. Quite high losses were also observed for the tomato and cucumber salad. After 2 hours of storing such a salad, these losses were over 50%. After 4 hours of storage, 65.8% of the initial content of vitamin C was lost from the salad. i.e. over two times more than from tomatoes without cucumber. After 24 hours, the amount of vitamin C in the salad was less than 20% (Fig. 1).

DISCUSSION

The tomato of Caniles variety under the study contained 18.55 mg of vit. C in 100 g of fresh weight, and 14.72 mg after shredding, which corresponds with the results published by other authors.

Depending on the variety, tomatoes may contain from 12.82 to 20.51 mg/100 g of fresh product weight [16]. Georgè et al. [4] provide values ranging from 15.8-17.1 mg/100 g. It is also known that some varieties (e.g. American H9478) may contain as much as 43.01 mg of vit. C in 100 g of the product [15]. In the comparison on the content of vit. C in juices made of 4 varieties of organic and conventional tomatoes, Hallmann and Rembiałowska [6] indicate slightly different, quite low content of vitamin C in tomatoes, which on average amounts to 8.04 mg in 100 g of organic tomatoes and 6.77 mg/100 g in conventional tomatoes. However, it should be noted that the content of vit. C in plant materials is variable and depends on a number of factors, not only depending on the type of crop, but also on other soil and climatic conditions and varieties [12].

The contents of vitamin C in raw cucumber of the Atar variety was 4.32 mg/100 g of fresh weight. According to other authors, fresh cucumbers may contain from 5.5 to 10.4 mg/100 g of fresh weight [5], or 8 mg of vitamin C in 100 g of edible part on average [10]. Just like in the case of tomatoes, the content of vit. C in cucumbers is a varietal trait, also dependent on soil and climatic conditions of growth.

In this study, it has been shown that shredding tomato caused losses of vit. C in the amount of 20.7% and with the loss of 37.4% for cucumber. In the process of peeling and shredding, the tissue and cellular structure is interrupted, which facilitates the access of oxygen to the interior of the raw material and affects larger losses of vitamin C [1].

Due to the solubility of vitamin C in water, its losses occur already during the initial washing or soaking of raw materials. Thermal processing also contributes to the reduction of water-soluble vitamins, which under the influence of boiling, blanching and stewing pass into juice. Losses occurring in this way can be as high as 40% [2]. Moreover, inadequate storage of raw materials, its processing and serving meals cause 50-70% of the loss of this vitamin [11].

The conducted study shows that the content of vit. C is reduced to different extents during storage of tomatoes and cucumbers, which are shredded and mixed together in the form of a salad. These losses are higher when one of these ingredients is fresh green cucumber. Mixing shredded tomatoes and fresh cucumber in a 1:1 ratio causes over 60% loss of vitamin C after 15 minutes in relation to the content in shredded raw materials. The obtained results may be grounds for the statement that the cause of high losses of vitamin C in the salad is ascorbinase, which is an enzyme contained in fresh cucumber. This enzyme in large quantities is contained not only in raw cucumbers, but also in squash or zucchini. Hence, it is not advisable to combine vegetables rich in vitamin C (i.e. tomato, cabbage, pepper) with raw cucumber. It is recommended to replace them with pickled cucumbers, as ascorbase is destroyed in the acidic environment [1]. However, literature data does not indicate to what extent vitamin C is destroyed by the addition of vegetables containing ascorbinase, which is why the results obtained in this study are important from both a cognitive and practical point of view.

In this study, it has been shown that storage of shredded tomatoes and cucumbers causes quite significant losses of vitamin C amounting to 30-75% after 2 hours of preparation. Salad prepared by mixing these ingredients after 15 minutes loses 62.4% of vitamin C contained in shredded raw materials, therefore these ingredients should be mixed max. 15 minutes before consumption.

CONCLUSIONS

Shredding raw materials causes losses of vit. C in the amount from 20.7% (tomato) to 37.4% (fresh green cucumber). Mixing these ingredients in a 1:1 ratio after 15 minutes causes the loss of vitamin C amounting to over 60%, in relation to the content in shredded raw materials. This suggests that in order to prepare tomato and cucumber salad, shredded ingredients should be mixed at latest 15 minutes before consumption.

Storage of the salad and its individual ingredients causes further loss of vit. C. After storing the tomato and cucumber salad for 2 hours, the content of vitamin C decreases by over 50%, while the decrease for tomato not assisted by cucumber is only 12.7%. The addition of cucumber to tomatoes causes loss of vitamin C higher by almost 40%. Shredded cucumber loses the most of vit. C: over 50% of the original content after 2 hours, almost 75% after 4 hours and over 94% after 24-hour storage.

After 24 hours of storing the tomato and cucumber salad, even 83.5% of the initial vitamin C content was lost, while the salad prepared with tomatoes only (without the addition of cucumber) lost twice as less vitamin C (39.2%). Probably such a large difference in vitamin C losses in salad (tomato with fresh cucumber), compared to losses from tomato (without cucumber), results from the enzymatic impact of ascorbinase present in fresh cucumber.

PODSUMOWANIE

Rozdrabnianie surowców powoduje straty wit. C w ilości od 20,7% (pomidor) do 37,4% (świeży ogórek zielony). Mieszanie tych składników w stosunku 1:1 powoduje po 15 minutach ponad 60% straty wit. C w stosunku do zawartości w rozdrobnionych surowcach. Fakt ten sugeruje, że w celu przygotowania sałatki pomidorowo-ogórkowej należy mieszać rozdrobnione składniki max. 15 minut przed spożyciem.

Przechowywanie sałatki i pojedynczych jej składników powoduje dalsze straty wit. C. Z sałatki pomidorowo-ogórkowej po 2 godz. przechowywania ubywa ponad 50% wit. C, podczas gdy z tych samych pomidorów, ale bez dodatku ogórka, ubywa jej jedynie 12,7%. Dodatek ogórka do pomidorów powoduje więc straty wit. C wyższe prawie o 40%. Rozdrobniony ogórek traci najwięcej wit. C: ponad 50% pierwotnej zawartości po 2 godz., prawie 75% po 4 godz. i ponad 94% po 24 godzinnym przechowywaniu.

Po 24 godz. przechowywaniu sałatki pomidorowo-ogórkowej ubywało aż 83,5% początkowej zawartości witaminy C, podczas gdy z sałatki przygotowanej z samych pomidorów (bez dodatku ogórka) ubywało ponad dwukrotnie mniej wit. C (39,2%). Prawdopodobnie tak duża różnica w stratach wit. C w sałatce (pomidor z dodatkiem świeżego ogórka) wobec strat z pomidora (bez dodatku ogórka) wynika z enzymatycznego oddziaływania askorbinazy obecnej w świeżym ogórku.

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