Vitamins retention in some microwave cooked dishes

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Abstract

Nowadays the consumer is more than ever the focus for food processors: time allowed for preparing food is shorter than older time, high requirement for food with nutrient value due to the applied techniques, better sensory quality and "easy-to-cook" techniques. The study was conducted on some dishes: fish dish, stuffed sauerkraut rolls and caramelized sugar cream, studying the influence of microwave heating on nutrients comparatively with cooking, in the oven. The study shows a good retention of some vitamins in microwave-cooked samples (9 - 44%) than in oven cooked samples

Key words: Food value, microwave heating, vitamins.

1. Introduction

The catering industry was advocated to use alternative methods of cooking in order to obtain: improved sensorial properties (or at least the same than in traditional methods of cooking), enzyme inactivation, microbiological destruction of pathogenic or spoilage organisms and last but not least superior nutrient value. (Amarfi *et al.,* 1996; Ryynanen, 2002)

Since the time allowed for preparing food is shorter nowadays, using of microwave heating is one of the most unconventional popular method of cooking, but very disputate. (Datta, 2001; Urehova *et al,* 2003)

Comparativelly with conventional methods of cooking using heat (e.g. grilling, roasting, stewing, braising, ovening), the microwave heating use very short electromagnetic waves that move the speed of light and have a wavelenght of between 1 mm to 30 cm. They are produced by a magnetron and are able to penetrate foods and cause an increase of temperature. The mechanism of this action is as follows: water is a polar molecule, this means that water molecules will behave like small magnets. When microwaves are directed at them, they will align themselves in a certain directions in the magnetic field which has been set up. As the current reverses, the directions of the field is changed and the molecules change their direction and turn through 180 degrees. This happens millions of times in a second. This continualy movement sets up friction which generate heat. Foods respond only to the electric portion of the microwave field; there are two major interaction mechanisms that cause heating. The first, dipolar rotation, depends on the influence of the microwave field upon dipoles. The perfect example of this is water. The high frequency microwave field, oscillating at 2450 MHz in microwave ovens, influences the vibration energy in the water molecule and other dipoles to cause frictional heating (Buffler, 1993; Chaplin, 2005; Cross, 1982). While materials other than water may be dipolar or may behave as dipoles due to the stress of the electric field, water usually dominates, probably because it is pervasive and at high concentrations in most foods (Ryynanen, 2002). The other heating mechanism is ionic conduction, which is a type of resistance heating depending on the acceleration of ions through solutions and the resulted multiple billiard-ball-like collisions. (Datta, 2001; Kala, 2004)

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Faculty of Food Science and Engineering
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This study is part of the doctoral disertation, and reffers on influence of microwave heating on some vitamins, when microwave heating was compared to conventional method of cooking in some traditional Romanian dishes. Also, this study investigate if the microwave heating aid the retention of proteins and if the quality is more favourable.

2. Materials and methods

2.1. The Romanian traditional meals

For this study it was used the Recipes Book issued by Ministry of Comerce in 1982, usually used by cooks in Romanian catering industry.

The selected Romanian menu contain 3 courses:
- appetizer – a fish dish
- the main course – stuffed sauerkraut rolls
- dessert – caramelized sugar cream

2.2. Sample preparation

The raw materials were supplied from different suppliers: hypermerket and free-market.. The experiment was conducted from April 2005 to July 2006. The meals were prepared according to the recipes, as follows:

2.2.1.The fish dish (A)

Because of un-conductive properties of bones, the fish was supplied boneless.

Preliminary operations: The fish was gently washed with cold water and than cut with a sharp knife into stripes. The onions were peeled, washed with cold water and than sliced with a sharp knife. The fish was mixed with sliced onions, canned tomatoes, oil, paprika, slice of garlic, thyme, bay leaf, ground black pepper, salt and white wine. The meal was divided into 3 portions at the same size. The first one (A1) was stored in the fridge, the second one (A2) was cooked in the oven for 40 minutes and the third one (A3) was cooked in a microwave oven (Galanz) for 20 minutes. The samples were cooked in a same size and shape pots.

The cooked samples were chilled and than stored in the fridge at 2°C.

2.2.2. Stuffed sauerkraut rolls (B)

According to the recipe, the peeled sliced onion was gently simmered with oil in a pot. Than, the beef meat and the pork meat was minced manually with the simmered onion. Than it were added washed rice and tomato sauce, paprika, ground black pepper, thyme and salt. The sauerkraut leaves were rolled with the mixture above. The meal was divided into three portions:

B1 – the sample was stored in the fridge;

B2 – the sample was cooked in the oven for 90 minutes;

B3 – the sample was cooked in the microwave oven for 30 minutes.

2.2.3. Caramelized sugar cream (C)

The eggs were gently washed and crushed into a pot to be beaten with a part of sugar and milk. The other part of the sugar was caramelized and divided in 3 pots: one part was poured in the mixture of eggs and milk (sample C1), the second sample was cooked in a conventional oven (sample C2); the third sample was cooked in a microwave oven (sample C3) for 7 minutes.

The samples of meals cooked into the conventional oven were A2, B2, and C2. They were placed on the second level of the oven and the hot temperature reached at 180^0 C and in the middle of the meal the temperature was 75 C in order to inactivate the pathogenic or spoilage microorganisms. The oven used in this experiment is a Rational oven.

For microwaving meals, it was used a domestic microwave oven, Galanz, type WD700-K2, rated power output 700 W, cavity dimensions 200×00×284 mm, cavity usable volume 17 l, glass turntable, feeding the cavity from the left wall.

For heating the samples it was used Glass vessel (Luminarc), round shape, inner diameter of 185 mm, high 78 mm, wall thickness 2 mm.

The experiment has been developed from May to November 2005.

The portion sizes of each sample analyzed are showed in table 1 and the cooking time of the analyzed meals are presented in table 2.

2.3. Analysis

Before performing analysis, all the samples were homogenized in a Vortex blender, as before digestion in the stomach.

For spectrophotometrically determination it was used a Cry-50 UV-VIS apparatus.

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Table 1. Portion size of analyzed meals (g)

Month / Sample	May	September	November
A1	400	400	400
A2	280	260	280
A3	300	280	320
B1	600	600	600
B2	340	400	320
B3	420	440	400
C1	400	400	400
C2	300	280	280
C3	360	300	320

Table 2 Cooking time of analyzed meals

Samples	Conventional oven (min)	Microwave oven (min)
A1	-	-
A2	40	-
A3	-	20
B1	-	-
B2	90	-
B3	-	30
C1	-	-
C2	30	-
C3	-	7

In order to evaluate the influence of different methods of cooking on nutrients the samples were weighted using an electronic scale Maxwell and than were dried using a vacuum drying closet.

All the data were reported on dry matter. The dry matter content of the samples is showed in table 3.

Table 3 Dry matter content of the samples, g%

Sample	Dry matter, g%
A1	16.02
A2	18.23
A3	17.36
B1	17.24
B2	19.23
B3	18.14
C1	20.14
C2	25.27
C3	22.21

For thiamine determination the recommended AOAC method, based on Jansen's thiochrome method was used. Under standard conditions, the net fluorescence of the thiochrome produced by the oxidation of the vitamin (using alkaline ferricyanide) is directly proportional to its concentration over a given range. The fluorescence was measured in a UV spectrofluorimeter. The results have been compared with the standard UV VIS spectre, as in figure 1.

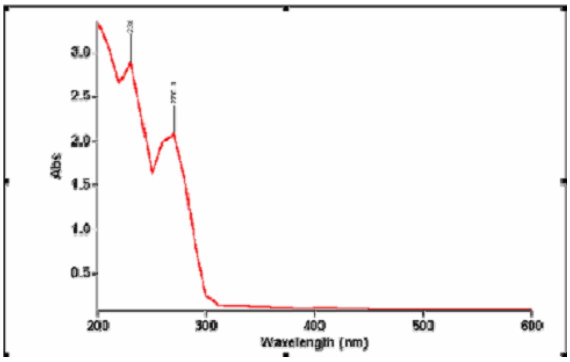

Figure 1. UV VIS standard spectre for thiamine

For riboflavin determination the fluorimetric method of analysis was also used, considering that it is in high quantity in the analyzed samples. Extraction of the vitamin from the sample is by acid hydrolysis, to yield a mixture of free riboflavin and FMN. The results have been compared with the standard UV VIS spectre, as in figure 2.

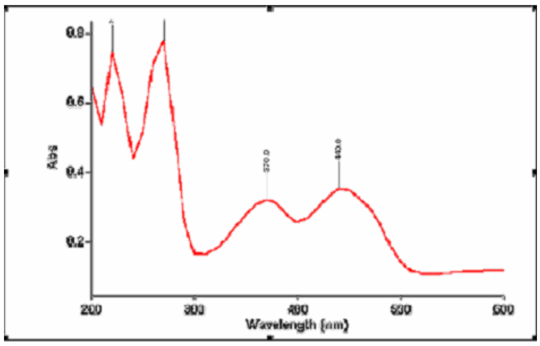

Figure 2. UV VIS standard spectre for riboflavin

For vitamin PP determination accordingly to AOAC recommendation for other water-soluble vitamins it was used the spectrophotometrical method. The results have been compared with the standard UV VIS spectre, as in figure 3.

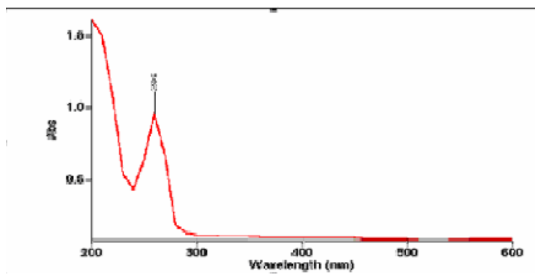

Figure 3. UV VIS standard spectre for niacin

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For vitamin E content it was used the Emmerie-Engel reaction determined the tocopherols spectrophotometrically. The results have been compared with the standard UV VIS spectre, as in figure 4.

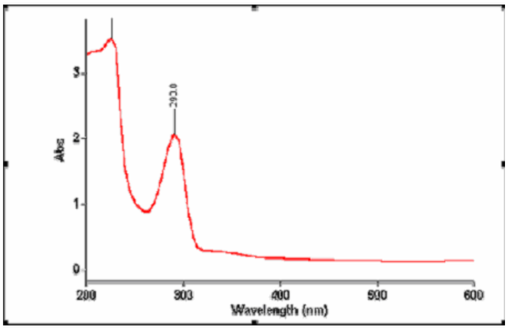

Figure 4. UV VIS standard spectre for tocopherols

The vitamin A content has been determinate spectrophotometrically (antimony trichloride and chloroform as reference). The results have been compared with the standard UV VIS spectre, as in figure 5.

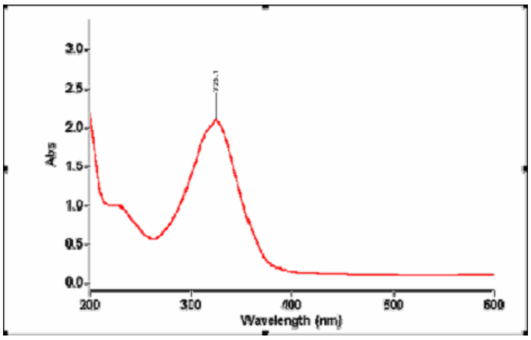

Figure 5. UV VIS standard spectre for trans-retinols

3. Results and discussion

For vitamin retention it was used Segal's recommended formula for apparent retention and real retention of nutrients, according to Murphy's formula:
- for apparent retention of nutrients:

$$\% \ \mathbf{R_a} = \frac{Np}{Nrm} \cdot 100 \quad (1)$$

where:
Np is nutrient content per gram in final product, g
Nrm – nutrient content per gram in uncooked product, g.

- for real retention of nutrients:

$$\% \ \mathbf{R_r} = \frac{Np \times \mathrm{P}}{Nrm \times \mathrm{RM}} \cdot 100 \quad (2)$$

where:
Np is nutrient content per gram final product, g
P – final product, g
Nrm – nutrient content per gram in uncooked product, g
RM – uncooked product, g.

The nutrient content has been calculated to dry matter. The results of retention of vitamins in Romanian dishes are shown in table 4 and figure 6.

Table 4. Vitamins retention in the samples analyzed

Vitamins	Sample	Retention, %	
		R_a	R_r
B_1	A1	100	100
	A2	14.45	10.12
	A3	62.65	46.92
	B1	100	100
	B2	92.90	52.64
	B3	91.17	63.82
	C1	100	100
	C2	66.66	50
	C3	76.06	68.46
B_2	A1	100	100
	A2	54.02	37.81
	A3	50.57	40.45
	B1	100	100
	B2	95.91	51.15
	B3	87.58	58.38
	C1	100	100
	C2	48.87	34.21
	C3	65.73	52.58
A	A1	100	100
	A2	61.99	43.39
	A3	93.97	75.17
	B1	~	~
	B2	~	~
	B3	~	~
	C1	100	100
	C2	70	49
	C3	90,6	72.48
E	A1	100	100
	A2	~	~
	A3	~	~
	B1	~	~
	B2	~	~
	B3	~	~
	C1	~	~
	C2	~	~
	C3	~	~

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Table 4. (*continued*)

PP	A1	100	100
	A2	82.35	53.52
	A3	28.23	19.76
	B1	100	100
	B2	~	~
	B3	~	~
	C1	~	~
	C2	~	~
	C3	~	~

The retention of some vitamins in some dishes was under the detection sensitivity of the apparatus and it wasn't possible to evaluate the phenomenon.

Since the microwave heating is also a heat treatment, but in shorter time than in conventional oven, the results show that the nutrient retention is different in samples B than in samples A and C. That demonstrates that the behavior of nutrients in food during heat treatment is highly influenced of food composition, especially of water content. Under heat treatment, thiamine is broken into pirymidinic and thyazol nucleus, loosing also the vitamin activity.

This experiment shows that the remained thiamine is higher in microwave samples (62% in sample A3 and 76% in sample C3) comparatively with B samples, when the behavior was different (93% in the oven sample and 91% in the microwave sample). The possible explanation is that under alkali pH, like in meat products, the destruction of thiamine under heat processing is higher than in acid pH. Since thiamine is involved in the oxidation of nutrients and the release of energy in the body, and the food processing is highly related with its losses, microwaving food can be an appropriate approach for catering industry.

For riboflavin retention, another water-soluble compound involved also in energy release form food, being part of the enzyme system concerned in the oxidation of glucose and the release of energy in body cells, the experiment shows that is fairly stable to heat, the retention in samples A and C the retention is higher in microwave samples than in oven samples (48% for sample A3 and 69% in sample C3, comparatively with 15% in sample A2 and 12% in sample C2). In sample B the behavior of riboflavin is as similar with thiamin behave, the retention being higher in the oven sample (74%) than in the microwave sample (52%). That shows also that riboflavin is less stable in alkaline condition (like in meat dishes).

Also, the coverage of nutrients in Recommended Daily Allowances (table 5) shows a good coverage for micro waved dishes than for conventional cooked dishes.

Table 5 Coverage of nutrients in RDAs

Sample	**B1**	**B2**	**A**	**E**	**PP**
A1	5.31	6.15	1.38	69.8	0.02
A2	**0.61**	**0.66**	**0.97**	**~**	**0.013**
A3	**2.70**	**2.23**	**1.40**	**33.5**	**0.0028**
B1	59.78	17.79	~	~	0.012
B2	**35.11**	**9.84**	~	~	~
B3	**40.15**	**7.10**	~	~	~
C1	9.42	18.68	3.32	~	~
C2	**5.91**	**2.05**	**2.91**	~	~
C3	**7.11**	**10.66**	**3.32**	~	~

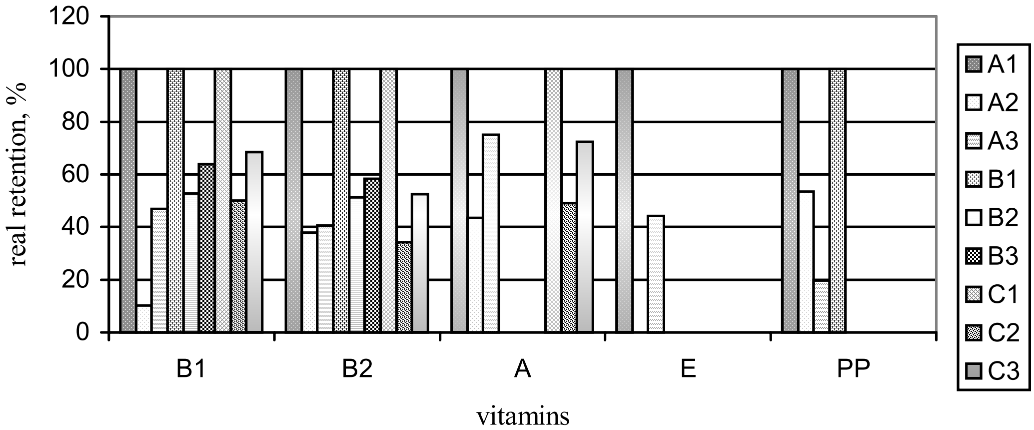

Figure 6. Real retention of vitamins in analyzed samples

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As it can been seen the coverage for nutrients in micro waved dishes is different in dishes, higher with 22% to 87% for thiamin in microwave dishes, lower with 72% in B samples and higher with 19% to 29% in samples A and C, higher with 69% to 87% for retinols in samples where this vitamin could be evaluated, but for niacin is 464% lower in microwave dishes than in traditional cooked dishes.

4. Conclusion

The study shows some conclusion:

– water is the most important factor in microwavable foods, and the success or failure of nearly all foods products depends upon how the water is managed;

– time is another important factor which can explain the behavior of vitamins and minerals during heating, accordingly with the same sensory properties and food safety;

– higher retention of vitamins have been determinate when microwave heating was compared to conventional methods due to shorter time and smaller amount of water used in cooking.

– meat dish behave different than fish and egg & milk dishes when microwave heated, alkali pH can be an explanation of this behavior;

– drawing a comparison between the two ways of cooking, while instrumental measurements indicated some differences of vitamins and minerals retention, the consumers perceive only small difference in some sensory attributes;

– the study haven't been conducted in order to demonstrate if cooking in microwave is dangerous for healthy or not, but during the research I've done, I found several information about hidden hazards of microwave cooking, concerning mainly the high risk for burning if the pots are not manipulated with gloves; other studies shows a strong destructive effect of microwaves on *E. coli*, *B. subtilis* in micro waved food

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