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RESEARCH NOTE

The effect of microwave heating on retention of some B vitamins

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The effects of microwave heating on the retention of selected nutritional components in animal muscle was studied. We determined the degree of retention of the thermolabile vitamin B_6 and thiamine after thermal treatment of pork and chicken meat in a conventional oven (Tatramat) and in a microwave oven (model GUM 2S [A] and Toshiba ER-5300D [B]).

In conventionally roasted samples 48–96% of thiamine was retained, whereas microwave-treated samples showed retention as high as 85·6–94·2% (oven A) and 88–96% (oven B).

After conventional roasting, meat samples retained only 21·6–48·5% of vitamin B_6. Microwave treatment, on the other hand, retained 59·9–80·9% (oven A) and 64·2–86·8% (oven B) of vitamin B_6.

The measured values of vitamin retention demonstrate clearly that heating of muscle tissue with microwaves is less destructive to heat-sensitive vitamins than is conventional roasting and that, therefore, microwave cooking and roasting can be recommended for food preparation in the food industry, households, restaurants and hospitals.

INTRODUCTION

Heating of food with microwaves has become a widespread, progressive method of preparation of meals with nutritional value. Microwave cooking has been so far applied in the food industry to cooking, warming, drying, thawing, pasteurization, sterilization and blanching (McConnel, 1975; Hozová, 1990).

Many authors have pointed out the advantages of microwave cooking over conventional methods (McConnel, 1975; Decareau, 1984; Ohlsson, 1984). An important application of microwave warming of food in children's hospitals has been suggested by Ohlsson & Thorsell (1984). The authors also stressed the high sensoric value of such food.

There seems to be general consensus that microwave ovens will spread even further and will be widely used in technological operations, in restaurants, schools and households. That is why we set out to determine the nutritional value of microwave-treated foods.

Earlier studies on the effects of microwave cooking on the retention of the nutritionally valuable components of food proved the superiority of this method (Kahn & Livingston, 1970; Bowers & Craig, 1978; Bognár, 1978; Uherová *et al.*, 1980) over conventional cooking.

Now we discuss the effects of the microwave heating of food on the retention of thermolabile vitamins, thiamine and vitamin B_6.

MATERIALS AND METHODS

The changes in content of vitamins B_1 and B_6 in pork (flat-cut and ground) and in cut chicken were determined in raw meat, roasted in conventional and microwave ovens respectively.

The meat samples were treated in two microwave ovens, one currently under development in Czechoslovakia (GUM 2S) and Toshiba (Japan), model ER-5300D. The reference samples were prepared in a conventional electric oven Tatramat (CSFR), input power 1800 W, temperature 180°C. Thermal treatments are summarized in Table 1. Both raw and heat-treated meat samples were ground for anlaysis and the following parameters determined:

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Table 1. Thermal treatment of meat samples

Meat from market	Number of samples	Cooking time (min)			Internal temperature (°C) ± 2°C microwave and conventional
		Conventional oven		Microwave oven	
		Electric Tatramat	GUM 2S	Toshiba ER-5300D	
Pork-raw muscle sections (100 g)	20	30	3	3	85
Pork (minced)	20	30	2	2	80
Chicken (quartered)	20	50	5	5	80

—dry matter after to constant weight at 105°C;
—vitamin B_1 (thiamine) content by the thiochrome method (AOAC, 1984);
—vitamin B_6 content (total pyridoxine) by microbiological assay (AOAC, 1984).

RESULTS AND DISCUSSION

The vitamin B content of microwave-treated muscle samples was compared with that of the conventionally roasted meat. The results are summarized in Table 2, the content of vitamins being given as an average value; the effects of thermal treatment are given as average values of retention. The relative statistical deviation was 0·4–15·5% for thiamine 0·7–15·4% for vitamin B_6.

The extent to which microwave heating affected the content of vitamin B was measured in two types of pork and chicken meat. In the raw minced pork the thiamine content varied from 2·44 to 3·58 mg per 100 g of dry matter. After conventional roasting the content was down by 33% on average, whereas in microwave-treated samples (both in oven A and oven B) the decrease in vitamin content was only slight, 5·8 and 4·0% respectively.

In raw pork steak the content of thiamine was found to be 1·97–3·50 mg/100 g of dry matter. After conventional roasting the content decreased by 39·4%. In contrast, microwave treatment elicited a decrease of 14·4% (oven A) and 9·6% (oven B) respectively.

In raw chicken meat there was 0·24–0·28 mg of thiamine in 100 g of dry matter. Conventional roasting decreased the content on average by 52%; microwave treatment in oven A caused a decrease of 8%; in oven B it was 12%.

The content of vitamin B_6 in raw pork steak decreased after conventional roasting from the original 0·45–0·72 mg/100 g of dry matter by as much as 56%; the microwave treatment in oven A caused a decrease of 37·7, and in oven B 28·3%. In minced pork the corresponding values are as follows: 0·49–0·00 mg/100 g of dry matter in raw steak, a value which decreased by 51·5% after conventional roasting and by 19·1 and 13·2% after the treatments in ovens A and B respectively.

We conclude that heat treatment of pork and chicken in microwave ovens leads to smaller losses of vitamins B_1 and B_6 than in conventional electric ovens. Moreover, similar results were obtained with microwave ovens which differed in power and design.

Table 2. Vitamin content and retention of vitamins in heat-treated meat samples (mg per 100 g of dry matter)

Meat	Oven	Thiamine		Vitamin B_6	
		$\bar{x}$	Retention (%)	$\bar{x}$	Retention (%)
Pork (minced)	Raw material	2·76 ± 0·087	100·0	0·68 ± 0·044	100·0
	Roast	1·85 ± 0·083	67·0	0·33 ± 0·031	48·5
	Microwave A	2·60 ± 0·020	94·2	0·55 ± 0·005	80·9
	Microwave B	2·65 ± 0·091	96·0	0·59 ± 0·040	86·8
Pork (steak)	Raw material	2·08 ± 0·37	100·0	0·53 ± 0·03	100·0
	Roast	1·26 ± 0·130	60·6	0·23 ± 0·011	43·4
	Microwave A	1·78 ± 0·191	85·6	0·33 ± 0·02	62·3
	Microwave B	1·88 ± 0·11	90·4	0·38 ± 0·018	71·7
Chicken (quartered)	Raw material	0·25 ± 0·02	100·0	1·62 ± 0·091	100·0
	Roast	0·12 ± 0·012	48·0	0·35 ± 0·037	21·6
	Microwave A	0·23 ± 0·010	92·0	0·97 ± 0·108	59·9
	Microwave B	0·22 ± 0·100	88·0	1·04 ± 0·101	64·2

Microwave A: GUM 2S, operating at 2500 MHz, 2000 W input power.
Microwave B: Toshiba ER-5300D, 2450 MHz, 940 W.
$\bar{x}$ average from 20 sample and two parallel assays, statistically evaluated (deviation).

In this respect our results accord with those published by Bognar (1978), who assessed the loss of thiamine during several roasting procedures and found it to be 25–62%. Bowers & Craig (1978) also determined the loss of vitamin B_6 during microwave heating. McConnel (1975) determined the retention of thiamine during heat treatment of some fish and meats in conventional and microwave ovens and found the loss to be 33–43% in conventional and 4–28% in microwave ovens respectively.

We have also taken into account some older data on the topic, namely that of Mulley *et al.* on the kinetics of thiamine degradation of heat (1975), the stability of thiamine to heat by Beadle *et al.* (1943), the results of Bendix *et al.* (1951) on the stability of thiamine during heat sterilization, as well as those of Farrer (1945*a,b*).

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