COMPARATIVE STUDY ON NUTRITIVE VALUE OF MEAT (SEMITENDINOSUS MUSCLE) USING MICROWAVE AND CONVENTIONAL COOKING

S. KARAKAYA, A. KAVAS and S.N. EL

Ege University Engineering Faculty Food Engineering Department 35101 BORNOVA-İZMİR

ABSTRACT

In many countries, microwave ovens are used because of the convenience and time savings in cooking. Therefore, the objectives of this study were to compare the effects of microwave and electrical ovens on retention of some nutrients and to determine the differences in terms of nutritive value and consumer preference, between the meat cooked by these two methods.

Moisture, protein, riboflavin, niacin, pyridoxine, iron, and calcium were found to be higher in the meat cooked in microwave oven compared to the electrical oven. Fat content of meat cooked in electrical oven was greater than the meat cooked in microwave oven.

Cholesterol content was influenced by cooking methods. No significant differences were found between the microwave and electrical ovens as far as flavor and texture characteristics of the meat are concerned, but panelists prefered the meat cooked in electrical oven for appearence.

INTRODUCTION

In many countries, including Türkiye, microwave cooking and processing has increased over the years because of the convenience and time saving. Recent improvements in the design of high-powered microwave ovens offer rapid and economic methods for manufacturing food products of high organoleptic properties and nutritional value (Mudgett, 1989).

In the food industry, microwave is used for pasteurization of packaged bakery products, sterilization (Sale, 1976 ; Decerau, 1986), tempering of frozen foods, precooking of poultry and pork products and drying of pasta, onions, condiments, tamoto paste, snack foods and bacon pieces (Mudgett, 1989).

Since microwave ovens are used extensively for cooking, thawing and reheating at homes and institutions, nutrient retention in foods processed by microwaves is of importance. In the studies done to compare the effects of microwave and conventional cooking on nutritive value, inconsistent results were obtained.

The moisture content of meat cooked in microwave oven was found to be higher than the meat cooked by conventional methods (Baldwin et. al., 1976 ; Cross and Fung, 1982).

Protein contents of meats cooked in microwave oven were also higher than the meats cooked in conventional ovens (Cross and Fung, 1982).

Any effects of microwaves on the lipid fraction in foods appeared to be minor. Microwave reheated turkey breast muscle was analyzed to determine the extent of oxidation, and TBA values were found to be higher in conventionally reheated turkey breats (Cross and Fung, 1982).

Fatty acid composition of raw and microwave cooked chicken, beef and bacon fats were not found different. After cooking in the microwave oven, no trans fatty acid was formed in either chicken or bacon fat which contain high concentrations of oleic and linoleic acids (Mai et. al., 1980).

Thiamin, riboflavin, niacin and pyridoxine content of foods cooked in microwave oven were found to be same or greater than foods cooked by conventional methods (Baldwin et. al., 1976; Johnston and Baldwin, 1980; Chung et. al., 1981 ; Payton and Baldwin, 1985 ; Dawson et. al., 1988).

In Türkiye, to our knowledge, no detailed studies were done on the nutrient losses of microwave versus conventionally cooked foods. Therefore, the objectives of this study were to compare the effects of microwave and electrical ovens on retention of some nutrients and to determine the differences in terms of nutritive value and consumer preference, between the semitendinosus muscle cooked by these two methods.

MATERIAL AND METHODS

Semitendinosus muscle was bought from a local butcher shop. After removing the external fat, the muscle was cut into halves for microwave and electrical cooking. Two and a half cm thick slices of the muscle were cooked in a microwave oven (Vestel Goldstar, 2450 MHz and 980 W, Organize Sanayi Bölgesi, Manisa-Türkiye) for 14 minutes and the other silices were cooked in an electrical oven (Arçelik marka, Çayırova İstanbul-Türkiye) for 35 minutes at 170^{o}C. These cooking times were selected after a pretest to provide the same doneness of the meat cooked in both ovens. Internal temperature was determined with an insertion type thermometer placed in the meat immediately after cooking. At the same level of doneness, internal temperature of the microwave and electric cooked muscles were found to be 84.80^{o}C and 74.94^{o}C, respectively. The differences between the internal temperatures occured because of the differences between the heating mechanisms of microwave oven and electrical oven.

Drippings were added to muscle for analyses. Moisture, ash, protein, iron and calcium contents of the raw, microwave or electrically cooked samples were determined according to the methods of AOAC (1980). Protein was calculated using the conversion factor of N*6.25.

Fat contents of the raw meat and the muscle cooked in both ovens were determined using chloroform-methanol extraction method (Flayn and Bramblett, 1975). Cholesterol contents of the meat samples were determined by the method of Prusa and Hughes (1986).

Immediately after cooking, riboflavin, niacin and pyridoxine contents of the meat samples were determined by the method of Dawson et. al. (1988), using High Pressure Liquid Chromotography (Model ALC/GPC, Pomp. M. 6000 A, injection UGK). Recovery samples were prepared by adding a known amount of reference riboflavin, niacin and pyridoxine prior to the extraction process.

Sensory evaluation of the consumer panel on semitendinosus muscle cooked in microwave and electrical ovens was done using the paired comparisons method (Amerine et. al., 1965).

The data were analyzed statistically by the Student's t-test. Statistical analysis of the sensory evaluation was done according to Kramer et. al. (1970), which is recomended for paired comparisons.

RESULT AND DISCUSSION

Weight losses of semitendinosus muscle cooked in microwave and electrical ovens were found to be 34.71 % and 36.55 %, respectively, but no statistically significant differences were determined.

Moisture content of semitendinosus muscle cooked in microwave oven was higher than that of the muscle cooked in electrical oven (Table 1). Riffero and Holmes (1983) reported that a significantly greater amount of moisture was retained in the meat cooked by microwaves than broiling. In contrast, Janicki and Appledorf (1974) found greater total moisture in broiled beef patties than in microwave cooked patties. In the study of Payton and Baldwin (1985), differences between the moisture content of top round steaks cooked in the microwave-convection oven or convection turbo oven and conventional electric oven were not found significant.

The meat cooked in electrical oven had lower ash content than the meat cooked in microwave oven. In the electrical oven all of the drippings could not be added to the muscle for analysis because of drying and sticking

of drippings on bottom surface of the plate. Lower ash content obtained for electrical oven might be due to losses in drippings which might be excessive due to cross-sectional cut of the muscles.

Protein content of semitendinosus muscle cooked in electrical oven was found to be significantly higher ($p < 0.05$) than the muscle cooked in microwave oven on a cooked weight basis being 28.43% and 26.07% respectively (Table 1). However, when calculated on a dry weight basis protein content and retention were greater in microwave cooked samples (97.04% for microwave cooking and 93.44% for electrical cooking). Similar results were obtained in other studies.

Fat content of the muscle cooked by microwaves was lower than that of the muscle cooked in electrical oven (Table 1). This finding is agreement with the results of Janicki and Appledorf (1974). Therefore microwave cooking can be recomended for persons on low fat diets.

Both microwave and electrical cooking resulted in higher cholesterol in comparison with the raw meat possibly due to decreases in the weights of muscles (34.7% in the microwave and 36.5% in the electrical oven). On a wet weight basis cholesterol content of meat was lower following microwave cooking ($p < 0.05$) compared to the electrical oven (Table 1). This might result from lower fat content of the meat cooked in the microwave oven. Retention values obtained by microwave and electrical cooking were 167.10% and 174.73% respectively but no significant differences were found between the cooking methods (Figure 1). These results agree with the findings reported by Feeley et. al. (1972), and Rhee et. al. (1982).

Riboflavin content of meat was found to be higher following microwave cooking than the riboflavin content of the meat cooked in electrical oven (Table 2). Riboflavin retention of the samples cooked in electrical and microwave oven was 68.10% and 81.46% respectively (Figure 1). Chung et. al. (1981) found higher riboflavin retention by microwave cooking whereas other researchers showed no significant differences between riboflavin content of the meat cooked by microwaves and conventional methods (Johnston and Baldwin, 1980; Cross and Fung, 1982; Payton and Baldwin, 1985).

On a percent retention basis, niacin was significantly higher (96.50%) in the meat cooked by microwaves (Figure 1). Lower niacin retention (75.71%) obtained for the electrical oven might be due to losses of drippings and exposure to heat for a longer time.

Pyridoxine content and retention value of muscle cooked in microwave oven was higher than that of the samples cooked in electrical oven (Table 2 and Figure 1). Statistically significant differences were found between the retention values ($p < 0.01$). Cross and Fung (1982) reported that pyridoxine values of turkey breasts cooked in microwave oven were significantly higher on a cooked weight basis. Conversely, in a later study, using similar conditions with pork muscle Bowers et. al. (1974) reported that pyridoxine values were higher on the basis of dry weight but not statistically different when calculated on a cooked weight basis.

Iron content and retention of the muscle cooked in microwave oven was found to be higher than that of the muscle cooked in electrical oven (Table 2 and Figure 1). These differences between the iron content of meats might be due to losses of drippings by drying and sticking in electrical oven. Baldwin et. al. (1976) found that iron retention of beef cooked in microwave or conventional gas oven were 70% and 98%, respectively. In this study iron retention obtained for electrical oven was 64.78%. These differences between the iron retentions might be due to differences between the type of oven, oven temperature and internal temperature of meats used in both studies.

Table 1. Moisture, ash, protein, fat, and cholesterol contents of meats cooked in the microwave or electrical oven[a]

Meat	moisture %	ash %	protein %	fat %	cholesterol mg/100g
raw	77.40±0.82[b]	1.09±0.04	21.31±0.69	1.58±0.24	31.79±1.10
cooked in microwave oven	72.96±2.34	1.35±0.09	26.07±0.76	1.47±0.29	43.98±2.74
cooked in electrical oven	69.50±1.09	1.33±0.12	28.43±0.82[c]	1.96±0.46	56.12±6.40[c]

a: on a cooking weight basis
b: mean ± standard deviation
c: $p<0.05$

Table 2. Riboflavin, niacin, pyridoxine, iron and calcium contents of meats cooked in microwave or electrical oven[a]

Meat	riboflavin mg/100g	niacin mg/100g	pyridoxine mg/f00g	iron mg/100g	calcium mg/100g
raw	0.17±0.01[b]	4.74±1.08	0.64±0.26	2.02±0.14	5.27±0.45
cooked in microwave oven	0.16±0.01	5.07±0.57	0.59±0.13	1.87±0.36	5.90±0.64
cooked in electrical oven	0.15±0.02	4.65±0.58	0.38±0.02	1.75±0.20	5.16±0.68

a: on a cooking weight basis
b: mean ± standard deviation

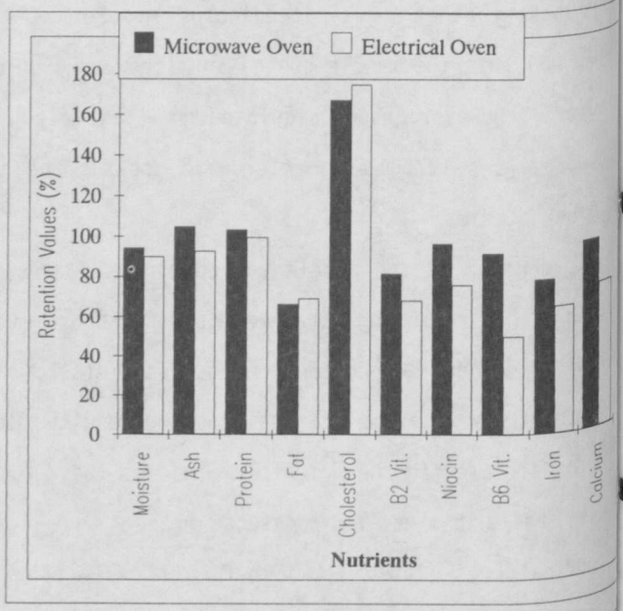

Figure 1. Retention values of nutrients in meats cooked by microvave or electrical oven

Calcium content of meat cooked in microwave oven was higher than that of the meat cooked in electrical ove (Table 2). Lower calcium retention obtained for electrical oven might be due to losses of drippings by drying a sticking (Figure 1). Chung et. al. (1981) reported that conventional and microwave cooking processes resulted similar losses in calcium contents of the peas.

No significant differences were found between the microwave and electrical ovens as far as the flavor a texture characteristics of the meat are concerned, but panelists preferred the meat cooked in electrical oven fo appearance (99.9%). McNeil and Penfield (1983) using paired comparisons test for consumer sensory panel, reporte that the conventional convection and microwave ovens produced equally acceptable turkey roasts.

In conclusion, protein, riboflavin, niacin, pyridoxine ,iron and calcium contents of the meat cooked in microw oven were higher than the meat cooked in electrical oven. Except for appearance no significant differences wer found between the microwave and electrical ovens in terms of organoleptic properties. Other researchers reporte that mutagenic compounds did not occur in microwave cooked foods (Pensabene et. al., 1974 ; Mauron, 1980). Therefor use of microwave ovens can be recommended for cooking and reheating at homes or institutions because of ti saving and greater retention of many essential nutrients.

REFERENCES

AMERİNE, M.A.; Pangborn, R.M.; ROESSLER, E.B. 1965. "Principles of Sensory Evaluation of Food". Academic Press New York, p. 477-490.

AOAC, 1980. Official Methods of Analysis, (13 th Ed.) Association of Official Agricultiral Chemists, Washington D.

BALDWİN, R.E.; KORSCHAGEN, B.M.; RUSSELL, M.S. 1976, Proximate analysis, free amino acid, vitamin and minera content of microwave cooked meat. J.Food Sci. 41, 762-765.