A3

IRON IN MEAT: EFFECT OF COOKWARE

HELEN C. BRITTIN
College of Human Sciences, Texas Tech University, Lubbock, TX 79409, USA

Keywords: Iron, Cookware, Preparation

Introduction. Iron deficiency is widespread and is mainly caused by inadequate intake and poor availability of iron from food (Cook, 1977). When dietary iron is calculated, that obtained from cooking in iron or steel utensils should be considered. Enhancing factors (ascorbic acid and meat) increase absorption of nonheme iron (Monsen and Balintfy, 1982; Monsen et al., 1978), so iron added to food from cookware may be of greater importance than was previously recognized (Mertz, 1980). Cooking food in iron utensils increases its iron content (Burroughs and Chan, 1972; Brittin and Nossaman, 1986a). A survey of 366 persons showed that most people own (79%) and use (72%) iron cookware (Brittin and Nossaman, 1986b). The skillet was the cooking utensil used most often. Of the iron utensils owned, the skillet was reported by the most people (71%). Meat was the type of food the most people cooked in iron utensils. Iron added to food by cooking in iron utensils is bioavailable (Martinez and Vannucchi, 1986; Mistry et al., 1988). Iron cookware is durable, so it may be used for years, and used cookware increases the iron in food as much as new cookware does (Cheng and Brittin, 1991).

In the United States, the Asian population is increasing and Chinese food is popular. Chinese and Asian foods are often cooked in steel woks. Steel is 98% or more iron. A recent survey of Chinese living in the United States showed that most of them cooked frequently in steel woks, and cooking in steel woks increased the iron content of food (Zhou and Brittin, 1994). A recent survey of people from India who live in the United Sates showed that most of them cook frequently in Indian cookware (iron karhais, stainless steel karhais, and iron tavas), and cooking in iron karhais and iron tavas increased the iron in food (Brittin and Kollipara, 1994).

Objective. The objective of the study was to determine the effect of cookware on iron content of meat.

Methods. Eleven meats were subjected to three treatments: raw, cooked in glass utensil, and cooked in iron, steel, or stainless steel cookware. Additionally, the chicken curry was cooked in three (instead of one) iron karhais and in a stainless steel karhai. The glass utensil was Corningware (Corning Glass Works, Corning, NY). Other cookware used were iron skillet or karhai (resembles a wok), steel wok, and stainless steel karhai. Each treatment for a meat involved weighing the same food ingredients. Three replications were made. Cooking times were the same for both cooking treatments and all replications for a meat. Each meat sample was blended and its pH was determined. Duplicate 5 g samples of meats were dried, ashed, and analyzed for moisture and iron (Brittin and Nossaman, 1986a; AOAC, 1990). Ash was dissolved in nitric acid, and filtered samples were analyzed for iron by flame atomic absorption spectrophotometry (Model 5000, Perkin-Elmer, Norwalk, Conn) using standard ferric chloride diluted to 5 ppm. Recovery studies were performed and showed 98.5% or more recovery of the added iron. Statistical analyses included analysis of variance and Duncan's multiple range test. The study was a randomized block design and a factorial experiment -- 11 meats x 3 treatments x 3 replications x 2 samples.

Results and Discussion. Table 1 shows the iron content of the meats. Analysis of variance showed a significant effect of food and treatment on moisture and iron but no significant effect of replication and sample. Because moisture did not differ between food cooked in glass and metal utensils, the difference in iron content of food cooked by the two treatments was not the result of differences in moisture. All meats except liver with onions contained more iron ($P<0.05$) when cooked in an iron or steel utensil than in a glass utensil. These results that most meats increased in iron when cooked in iron or steel utensils is in agreement with results for a variety of foods (Burroughs and Chan, 1972; Brittin and Nossaman, 1986a; Zhou and Brittin, 1994). Recently a study reported that a steel wok and a cast-iron skillet used to boil an acid solution were equally good sources of iron (Kuligowski and Halperin, 1992). Cooking in the stainless steel utensil did not increase the iron in chicken curry, the only food cooked in it, while cooking this meat in iron karhais did significantly increase its iron content. Mean iron content of chicken curry cooked in three iron karhais did not differ significantly, thus different iron karhais affected iron content of food similarly. Of the 11 meats, chili with ground beef and beans increased most in iron content when cooked in an iron or steel utensil. This food had next to the lowest pH (raw), third longest cooking time, and third highest moisture content (raw). Low pH and high moisture content of raw food and long cooking time are factors related to the increase in iron in food from cooking in iron or steel cookware (Brittin and Nossaman, 1986a; Zhou and Brittin, 1994).

Conclusions. Cooking in iron or steel utensils increased the iron content of meat. Therefore, adjustments in assessing a person's iron intake shouldl be made if meat is cooked in iron or steel utensils. Nutrition educators, dietitians, and meat scientists need to be aware of the increased iron in foods, including meats, from cooking in iron and steel utensils.

Table 1. Cooking time and means for pH, moisture, and iron content of meats by treatment

Meat[a]	Utensil[b]	pH, raw	Cooking time (min)	Moisture (%)			Iron (mg/100 g food)		
				Raw	Cooked in glass	Cooked in metal	Raw	Cooked in glass	Cooked in metal
Chili with beef & beans	IS	5.27	36.0	78.31	72.27	71.55	0.98	1.28	6.27*
Stir-fried beef	SW	5.29	6.5	73.70	68.59	69.74	1.14	1.30	4.60*
Chicken curry	IK	5.61	41.0	74.28	64.85	66.48[c]	0.48	0.80	3.73[c]*
Spaghetti sauce with beef	IS	5.03	34.0	82.63	78.78	78.94	0.71	0.94	3.58*
Beef vegetable stew	IS	5.44	77.0	87.06	81.31	82.80	0.66	0.81	3.40*
Pan-broiled bacon	IS	6.37	5.0	34.92	18.78	20.98	0.77	1.29	1.92*
Fried chicken	IS	6.15	17.5	66.83	52.10	52.18	0.88	1.37	1.89*
Stir-fried chicken breast	SW	5.99	5.0	61.46	55.89	57.87	0.40	0.46	0.82*
Stir-fried pork	SW	6.28	5.0	59.75	55.26	53.76	0.88	0.97	1.27*
Pan-broiled hamburger	IS	5.77	9.0	58.89	59.22	56.75	1.49	2.00	2.29*
Pan-fried beef liver & onions	IS	6.10	11.0	75.37	63.15	63.16	3.10	3.82	3.87
Chicken curry	SSK	5.61	41.0	74.28	64.85	68.89	0.48	0.80	0.70

[a]Listed in descending order of increase in iron content of foods cooked in metal utensil over iron content of same food cooked in glass utensil.

[b]IS = Iron skillet, SW = Steel wok, IK = Iron karhai, SSK = Stainless steel karhai.

[c]Mean of chicken curry cooked in three iron karhais.

*Means for cooked in metal and cooked in glass utensils differ, $P<0.05$.

References

Brittin, H.C. and Kollipara, U.K. 1994. Iron content of some east Indian foods: effect of cookware. *J. Am. Diet. Assoc.* 94 (Suppl.): A-9 (abstract).

Brittin, H.C. and Nossaman, C.E. 1986a. Iron content of food cooked in iron utensils. *J. Am. Diet. Assoc.* 86: 897-901.

Brittin, H.C. and Nossaman, C.E. 1986b. Use of iron cookware. *Home Econ. Res. J.* 15: 43-51.

Burroughs, A.L. and Chan, J.J. 1972. Iron content of some Mexican-American foods. *J. Am. Diet. Assoc.* 60: 123-126.

Cheng, Y.J. and Brittin, H.C. 1991. Iron in food: effect of continued use of iron cookware. *J. Food Sci.* 56: 584-585.

Cook, J.D. 1977. Absorption of food iron. *Fed. Proc.* 36: 2028-2032.

Kuligowski, J. and Halperin, K.M. 1992. Stainless steel cookware as a significant source of nickel, chromium, and iron. *Arch. Environ. Contam. Toxicol.* 23: 211-215.

Martinez, R.E. and Vannucchi, H. 1986. Bioavailability of iron added to the diet by cooking food in an iron pot. *Nutr. Res.* 6: 421-428.

Mertz, W. 1980. Mineral elements: new perspectives. *J. Am. Diet. Assoc.* 77: 258-263.

Mistry, A.N., Brittin, H.C., and Stoecker, B.S. 1988. Availability of iron from food cooked in an iron utensil determined by an *in vitro* method. *J. Food Sci.* 53: 1546-1548 & 1573.

Monsen, E.R. and Balintfy, J.L. 1982. *J. Am. Diet. Assoc.* 80: 307-311.

Monsen, E.R., Hallberg, L., Layrisse, M. Hegsted, D.M., Cook, J.D., Merz, W., and Finch, C.A. 1978. Estimation of available dietary iron. *Am. J. Clin. Nutr.* 31: 134-141.

AOAC. 1990. *Official Methods of Analysis*, 15th ed. Association of Official Analytical Chemists, Washington, DC.

Zhou, Y.D. and Brittin, H.C. 1994. Increased iron content of some Chinese foods due to cooking in steel woks. *J. Am. Diet. Assoc.* 94: 1153-1156.