QUANTIFICATION OF FAT AND SALT UPTAKE IN COMMON FOOD PREPARATION METHODS

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Introduction

The Nutrition Coordinating Center (NCC) at the University of Minnesota maintains a nutrient database which was first established in 1974 to process dietary intake records for two national clinical trials involving subjects at risk for cardiovascular disease. Because fat intake was of primary importance to these studies, the nutrient database was structured to provide specificity for both the type and amount of fat used in food preparation procedures (Dennis et al., 1980 and Tillotson et al., 1981). Formulas were established that defined the amount of fat commonly added to foods by various preparation methods. In later studies concerned with hypertension, sodium intake was of additional interest, and formulas to quantify salt added during preparation also were developed.

Procedures for Specifying Type and Amount of Fat and Salt in Food Preparation

The two components of the NCC nutrient calculation system which allow this specificity for fat and sodium in food preparation are fat codes which specify the type of fat used in preparation, and preparation codes which quantify the amount of fat and salt to be added to a food prepared by various methods.

The use of the fat and preparation codes is shown in Table 1 for two different preparations of pork chops. In these examples, the fat code, CORN, indicates that corn oil is used in frying; nutrients for corn oil are automatically calculated and incorporated into the nutrient content of the fried pork chops. Each of the 100 margarine, 25 oil, and 20 shortening entries in the NCC nutrient database has a distinctive four-letter fat code which may be used as the cooking fat in any food preparation method. If a study participant does not know the preparation fat used, a default fat is automatically assigned based on the most commonly used fat in home or restaurant food preparation. If what is "most common" changes over time, the default fats can be changed with each new version of the nutrient database.

Preparation codes specify the amounts of fat and/or salt that are added to a standard amount of a food based on the type of preparation. There are currently 32 preparation codes in the NCC database, each designating a specific preparation method and represented by a three-letter code. In the first example in Table 1, PSN is the preparation code that designates meat that is pan fried with fat and salt. Use of the PSN code prompts the computer to add 0.16 ts of fat and 0.04 ts of salt for each ounce of meat. In the second example, a pork chop that is breaded and fried with salt is assigned a preparation code of BFS to prompt for the automatic addition of 1.06 ts of fat and 0.12 ts of salt, along with added flour, for each ounce of pork.

Use of the fat and preparation codes allows quantification of fat and salt used in preparation while keeping the size of the database at a manageable level for ongoing maintenance. By using computerized algorithms to add fat and salt to foods, the need for separate database entries for foods prepared in various ways is eliminated (Buzzard, 1989). For example, pork chops that are baked, fried, breaded and fried, or marinated in soy sauce can be handled with one basic pork entry plus preparation and fat codes, rather than requiring several hundred separate database entries to accomodate the four different preparation methods and the 145 fats that may be selected for each preparation method.

Need for Verification of the Preparation Formulas

The algorithms developed with the original NCC database system were based on data and cooking methods from 1974. Since then, better analytical methods have become available, and changes in preparation practices (e.g., use of less fat) may have occurred. Therefore, a pilot study was initiated in collaboration with the USDA Nutrient Composition Laboratory (NCL) to evaluate several of the NCC preparation formulas. The following six preparations were selected for analyses of fat and sodium uptake:

1. Meat fried in fat and salted;
2. Meat browned in fat, braised and salted;
3. Roasts browned in fat, baked or braised and salted;
4. Meat marinated in a commercial oil-containing marinade;
5. Meat marinated in a soy sauce mixture;
6. Egg fried in fat.

These preparation methods are ones which appear frequently on dietary intake records at NCC and for which limited data on fat and sodium uptake are available. Current household cookbooks were used to select foods commonly prepared by each method, as well as to determine the typical amount of added fat and salt and the length of cooking or marinating time. Cookbook preparation specifications for added fat and salt are shown in Table 2.

Preparation of the Samples and Analytical Procedures

In general, for each food; three control and three treated samples were prepared. Each sample, except roasted meat, consisted of four to eight units (i.e. chops or steaks). Meat cuts and poultry were purchased from a single grocery store outlet in Beltsville, Maryland. With the help of the store's meatcutter, cuts of similar thickness and marbling were obtained and distributed among the samples to minimize the inherent variability among cuts. For the control samples no fat or salt was added; water was substituted for the liquid portion of marinade mixtures. For certain foods frying pans were treated with non-stick spray to facilitate cooking in the absence of oil or fat. Treated samples were prepared with amounts of oil and/or salt according to protocol developed from recipes in popular cookbooks or by instructions on the packaged marinade products.

After samples of each meat were cooked, they were cooled for a predetermined amount of time and then dissected into the separable lean portion, if appropriate, and homogenized in a Model R-2 Robot Coupe food processor. Aliquots were stored in polyethylene containers at –40 degees C until analyzed.

In addition to the preparation of the above foods, five samples of each of three popular Chinese dishes (Moo Goo Gai Pan, Beef with Broccoli, and Chicken Chow Mein) were purchased from restaurants in the Washington, D.C. area. Additional samples were prepared from two major retail brands of Chicken Chow Mein. After homogenization, samples were analyzed for total fat and sodium.

Total fat was determined by the modified Folch procedure, a technique which includes the extraction of sample

lipid by a mixture of chloroform:methanol(2:1) followed by separation, evaporation, and weighing of the residue.

For sodium, samples were prepared using a wet ash nitric acid/hydrogen peroxide digestion. Sodium was determined by atomic emission spectrometry using Perkin-Elmer Model 603 spectrophotometer. The accuracy of the method was validated by the analysis of standard reference materials which have certified sodium concentrations. All reference materials analyzed provided concentrations whose mean ± uncertainty overlapped with the recommended mean ± uncertainty provided by the National Institute of Standards and Technology, which supplies these materials.

Results and Discussion

Differences in fat levels on a per weight basis between control and treated samples indicate that the fat content of several products substantially increased in pan fried cube steak (1.5x), braised pork chop (1.2x), fried (and basted) egg (1.3x), and braised beef roast (1.5x) as a result of procedures used and levels of fat added (Table 3). No significant differences were apparent between the control and treated samples of the round tip roast (dry heat). Notable increases in fat levels occurred as a result of stir frying non-marinated beef in oil (control, 6.5 g/100g vs treated, 8.7 g/100g). However, there was no significant difference in fat content between marinated and non-marinated samples when both were stir-fried in oil (8 g/100g vs 9 g/100g). Similarly, there was no difference between the fat levels for marinated and non-marinated boneless, skinless chicken breasts after broiling.

Dramatic increases (1.8-20x) in sodium values for food products occurred as a result of the application (or inclusion) of sodium chloride and/or soy sauce during food preparation (Table 4). Sodium values for pan fried cube steaks increased 5x above control values while values for braised pork chops increased 9x. Sodium values for the chuck blade beef roast (braised) and round tip roast (dry roasted) increased 3x and 2x, respectively. The marination of chicken breasts increased sodium values by 3x over control values. The largest increases (20x) over control values occurred in sirloin steak strips which had been marinated in a soy sauce-oil mixture. Observed results for the preparation methods described above pertain only to the amounts of fat and salt and conditions tested and do not necessarily reflect the effects of larger amounts of fat and salt in other recipes.

The survey of fat and sodium values for three different Chinese dishes procured from five to seven locations indicated greater variability in total fat levels than in sodium levels (Table 5). For total fat, mean values ranged from 3 to 9 g/100g of prepared product. Standard deviations range from 2.2 to 3.0 g/100g (coefficients of variation: 37-73%). Sodium values range from 451 to 544 mg/100g of prepared product. Coefficients of variation for sodium range from 18-25%. These preliminary data demonstrate that levels of some components in restaurant samples of combination foods particularly ethnic foods, may be highly variable and dependent upon specific recipes. The data serve as a caution to users of nutrient data, showing that it is important to consider not only the mean value but also the variability about the mean.

Changes in NCC Preparation Formulas

The data generated by the NCL have enabled the NCC to either verify or update the preparation algorithms based on current preparation methods. Changes in algorithms were made in version 17 of the NCC Nutrient Database released in 1990. Table 6 shows the changes made in the NCC preparation rules based on these new data:

1. The amount of fat uptake for pan fried or braised meat and for fried eggs was less than the existing NCC preparation rule. Sodium levels did not change for the meats.

2. Experiments on meat marinated in an oil-containing seasoning mix confirmed that oil was not absorbed

during marination; the amount of sodium was less than that specified in the existing NCC rule. Meat marinated in soy sauce, on the other hand, showed significantly greater sodium retention than allowed by the existing preparation rule.

3. Originally NCC had no preparation rule to add fat or salt to browned and salted roasts. These experiments demonstrated that roasts did absorb some fat, with uptake in the braised beef blade roast more than in the dry roasted beef round tip. However, since many study participants don't know if a roast was braised or cooked by dry heat, the fat uptake of the two cuts was averaged and applied to all browned and salted roasts which are not further specified. This average value provides a moderate estimate of amounts of fat attributable to preparation techniques.

Effect of Changes on Dietary Studies

Table 7 shows the effect of changes in the preparation rules on the calculated fat and sodium content in a typical serving of meat and eggs. Calculated changes in fat content differed by as much as 38% occurred due to changes in the preparation rules. However, it should be noted that a daily intake of 80-100g of food, would amount to a change of only 5% of the total fat. A substantial increase in sodium occurred in meat marinated in soy sauce. Three ounces of meat prepared in this way would contribute 25% of the sodium in a typical dietary intake of 4gm of sodium per day.

To avoid interpreting changes occurring in the database as trends in nutrient intake, studies that use the NCC system analyze all of their data using a single version of the database (Sievert et al., 1989). Changes in nutrients or preparation rules are not permitted in versions of the database already released for calculation of study data. At the end of a study, the data may be rerun on a newer version of the database to take advantage of correction of errors or better analytic data, including changes in the food preparation formulas.

It is important to keep the nutrient database current by incorporating data generated by new or updated food preparation methods. Chemical analyses of the actual fat and sodium uptake during preparation, rather than use of recipe calculations, provide a basis for estimating the amount of these nutrients in prepared foods where only a fraction of the added fat or salt may end up in the prepared product.

References

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TABLE 1

EXAMPLES OF USE OF FAT AND PREPARATION CODES

Example 1: 3 oz cooked trimmed loin pork chop, fried in corn oil, salted

Food Code: 11106 (11% fat pork)

Amount Eaten: 3 oz

Prep Code: PSN (pan fried with salt - adds 0.16 ts fat and 0.04 ts salt per oz meat)

Fat Code: CORN (corn oil frying fat)

Example 2: 3 oz cooked trimmed loin pork chop, breaded and fried in corn oil, salted

Food Code: 11106 (11% fat pork)

Amount Eaten: 3 oz

Prep Code: BFS (breaded and fried with salt - adds 1.06 ts fat, 0.12 ts salt and 0.29 oz flour per oz meat)

Fat Code: CORN (corn oil frying fat)

TABLE 2

COOKBOOK SPECIFICATIONS FOR ADDED FAT AND SALT

Preparation Method	Food	Fat	Salt
Pan fried with fat and salt	cube steak	1 tb fat/4 oz steak	1/8 ts salt/4 oz steak
Braised with fat and salt	pork chop	1/2 tb fat/4 oz chop	1/4 tb salt/4 oz chop
Roasted with fat and salt			
Braised	beef blade roast	4 tb fat/4 lb roast	2 1/2 ts salt/4 lb roast
Dry heat	beef round tip	4 tb fat/4 lb roast	5 ts salt/4 lb roast
Marinated in oil/seasoning mixture	chicken breast	1/4 cp fat/2 lb chicken	1 pkg mix/2 lb chicken
Marinated in soy sauce mixture	sirloin steak	1/2 cp fat/1 lb steak	1 cp soy sauce/1 lb steak
Fried with fat	egg	2 tb fat/egg	

TABLE 3

TOTAL FAT VALUES IN SELECTED FOODS

Preparation Method	Control[a]		Treated[a]	
	Mean (g/100g)	S.D.[b]	Mean (g/100g)	S.D.[b]
Pan fried cube steak	6.7	0.7	10.1	0.9
Braised pork chop	9.8	0.9	11.7	2.4
Fried egg				
basted[c]	11.7	0.6	15.5	0.5
without basting[d]			13.9	0.3
Roasted Beef				
Braised	9.1	1.5	13.9	1.8
Dry heat	7.5	1.7	8.05	1.0
Marinated chicken breast (broiled)	3.4	0.5	3.32	0.5
Marinated sirloin steak (stir-fried)	8.7	0.9	8.11	0.5

[a] Three replicates per method

[b] Standard deviation

[c] Fried in fat, fat spooned over yolk, covered

[d] Fried in fat, covered

TABLE 4

SODIUM VALUES IN SELECTED FOODS

Preparation Method	Control[a]		Treated[a]	
	Mean (mg/100g)	S.D.[b]	Mean (mg/100g)	S.D.[b]
Pan fried cube steak	86	3	443	34
Braised pork chop	87	7	792	7
Roasted Beef				
Braised	71	14	192	5
Dry heat	71	5	127	18
Marinated chicken breast (broiled)	51	1	174	11
Marinated sirloin steak (stir-fried)	68	-	1387	22

[a] Three replicates per method
[b] Standard deviation

TABLE 5

TOTAL FAT AND SODIUM LEVELS IN CHINESE FOODS

	FAT CONTENT			
Product	n[a]	Mean (g/100g)	S.D.[b]	CV[c] (%)
Moo Goo Gai Pan	5	7.5	3.0	40
Beef with Broccoli	5	9.0	3.4	37
Chicken Chow Mein	7	3.1	2.2	73

	SODIUM CONTENT			
Product	n[a]	Mean (mg/100g)	S.D.[b]	CV[c] (%)
Moo Goo Gai Pan	5	451	81	18
Beef with Broccoli	5	544	109	20
Chicken Chow Mein	7	456	114	25

[a] Number of samples analyzed
[b] Standard deviation
[c] Coefficient of variation

TABLE 6

CHANGES IN NCC PREPARATION RULES

	Prior to Version 17	Version 17
Per 1.0 oz Meat, Fish, Poultry, Organ Meat or Game:		
PSN Pan fried w fat & salt	0.5 ts fat 0.04 ts salt	0.16 ts fat 0.04 ts salt
BSS Braised w fat & salt	0.5 ts fat 0.04 ts salt	0.16 ts fat 0.04 ts salt
RBS Browned roasts w fat & salt	no fat or salt added	0.16 ts fat 0.02 ts salt
MSR Marinated in oil/seasoning mix	0 fat 0.04 ts salt	0 fat 0.02 ts salt
MAS Marinated in soy sauce mixture	0.06 ts soy sauce	0.38 tb soy sauce
Per 1 Large Egg:		
ESF Fried w fat	1.0 ts fat	0.62 ts fat

TABLE 7

NUTRIENT CHANGES IN TYPICAL PORTIONS

Changes in Total Fat Content

	Prior to V.17	Version 17	% Change
PSN* 3 oz cube steak	12.3 g fat	7.7 g fat	-38%
BSS 3 oz pork chop	15.9 g fat	11.3 g fat	-29%
RBS 3 oz beef roast	8.0 g fat	10.2 g fat	+27%
ESF 1 large egg	9.6 g fat	7.8 g fat	-18%

Changes in Total Sodium Content

	Prior to V.17	Version 17	% Change
MAR 3 oz skinless chicken breast	316 mg Na	188 mg Na	-40%
MAS 3 oz sirloin steak	120 mg Na	1241 mg Na	+934%

*PSN=pan fried with fat and salt; BSS=braised with fat and salt; RBS=roast browned with fat and salt; ESF=egg fried with fat; MAR=marinated in oil/seasoning mix; MAS=marinated in soy sauce mixture.