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USDA monitors levels of added sodium in commercial packaged and restaurant foods

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Abstract

This manuscript describes progress by the Nutrient Data Laboratory (NDL) in monitoring sodium in processed and prepared foods frequently consumed by the U.S. population. Recent concerns by the U.S. public health community about the intake of sodium by Americans have led ARS, USDA to develop a plan to monitor the levels of sodium in highly consumed commercial packaged and restaurant foods. NDL scientists worked with USDA's Food Surveys Research Group (FSRG) to identify 125 Sentinel Foods, to serve as indicators for assessment of change in the sodium content in the food supply. For each food (e.g., cheese pizza) NDL used market share data to identify the predominant brands and types of foods (e.g., frozen cheese pizza, restaurant pizza) to be monitored for changes in the sodium level over time. Periodically, nutrient values for frequently consumed foods will be updated by chemical analysis or label checks. Estimates will be compared to existing values in the National Nutrient Database for Standard Reference (SR). Since 2010, about 140 foods have been sampled and analyzed by NDL contractors. NDL will continue to generate new sodium data which will be disseminated in the successive releases of the SR. Accurate and current data for sodium in processed foods will support the assessment of changes in sodium in foods as well as the assessment of sodium intake by the U.S. population in the years ahead.

Keywords: food composition; sodium; national sampling

1. Introduction

The US health and medical communities have strongly encouraged the reduction of sodium in the diets of Americans in an effort to reduce the incidence of hypertension and cardiovascular diseases. In 2009, the Agricultural Research Service (ARS) of USDA, the Centers for Disease Control (CDC) and the Food and Drug Administration (FDA) launched a collaborative initiative to monitor sodium in the US food supply.

USDA's Agricultural Research Service and its predecessor organizations have been reporting sodium in foods since 1963. Sodium is found in the US food supply as sodium chloride, in leavening agents, and in other compounds which have been used for centuries to preserve foods and enhance flavor. Sodium is naturally present in many foods, including agricultural commodities. Levels in unprocessed commodities are relatively low (<100 mg/100 g for animal products, and <20 mg/100 g for plant products). The amounts of sodium in those foods support the physiological functions of animals or plants and cannot be

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reduced easily. However, in recent years the processing practices for some agricultural commodities have been modified for several reasons, resulting in products which contain higher levels of sodium compounds compared to those present in their unprocessed counterparts. For example, chicken breasts and pork loins are often injected with salt-containing broth or liquids to maintain moisture content during cooking. These treatments can increase the sodium content by three to five times the average physiological sodium levels per 100 g of food.

Salt added during cooking and on the table accounts for 5-10% of total sodium intake [1]. This proportion is expected to decrease, in the current food environment of increased use of processed foods and eating away from home. In contrast, commercially packaged and restaurant foods contribute more than 75% of the sodium in the typical US diet due to their frequency of consumption and the varying amounts of sodium present in the different foods and specific brands and types [2]. These foods include fast food and full service restaurant foods as well as commercial packaged foods sold in retail supermarkets and smaller grocery stores. Also, an increased number of prepared products have become available at convenience stores and quick-serve or carry-out stores. All of these foods are developed by manufacturers to meet certain functional requirements as well as taste, and therefore contain different amounts of sodium within a food type. The formulations of many commercial packaged and restaurant foods can be modified within limits defined by the food type to reduce sodium levels per serving or portion.

Many companies have joined efforts to reduce dietary sodium and are reformulating their products to achieve this goal. Since sodium-containing ingredients play important roles such as maintaining food quality and insuring food safety, each food company has to determine the most appropriate actions to be taken to reduce sodium in its product types.

To date, NDL/ARS has been monitoring nutrient profiles including sodium, for selected commercial packaged and restaurant food items sampled under the USDA National Food and Nutrient Analysis Program (NFNAP). These values are being used to establish a baseline for monitoring sodium and other nutrients in foods. This paper discusses procedures used by the Nutrient Data Laboratory (NDL) to monitor sodium in foods. The challenges of data acquisition for commercial packaged and restaurant foods will be addressed and selected results since the initiation of this program will be presented, including differences by food, brand and portion size.

1.1. Nutrient Values in the USDA National Nutrient Database for Standard Reference

The USDA National Nutrient Database for Standard Reference (SR) [3] is the major source of food composition data in the United States. The database is updated by scientists at NDL and released annually; the latest version is Release 25. SR contains data for about 8,200 food items, with up to 146 dietary components including traditional nutrients and more specific forms of certain components, e.g. carbohydrates, vitamin A, tocopherols, and emerging nutrients. Sodium data have been reported in USDA data products since 1963's Agriculture Handbook No. 8, 'The Composition of Foods: Raw, Processed, Prepared'. SR provides the foundation for most other databases in the US, including the Food and Nutrient Database for Dietary Studies (FNDDS) [4], which is the database used for processing dietary recalls in the nationwide survey, What We Eat in America, National Health And Nutrition Examination Survey (WWEIA, NHANES). Other uses include therapeutic, clinical, research databases (NDS-R) [5], product development, labeling, and nutrition policies and regulations, among others.

The development of nutrient values in the SR includes five steps: 1) acquisition of data from many sources; 2) evaluation of data quality; 3) aggregation of acceptable values; 4) compilation and calculations; and 5) dissemination. The food composition data are acquired from various sources (Figure 1): a) the USDA National Food and Nutrient Analysis Program (NFNAP) and other analytical projects; b) data obtained by USDA through industry collaborations on analytical projects; c) data developed by the industry, either analytical or calculated (for up to 14 nutrients to meet mandatory food labeling requirements); d) values calculated by NDL using established procedures, including recipe calculation and formulations; and e) limited data from the scientific literature. About 60% of the sodium data in SR are analytical; many other sodium values are derived (imputed or calculated) from analytical (Figure 1).

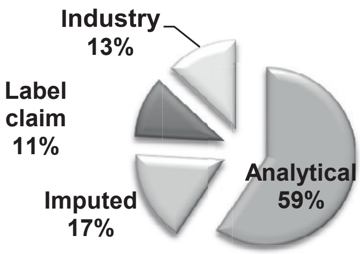
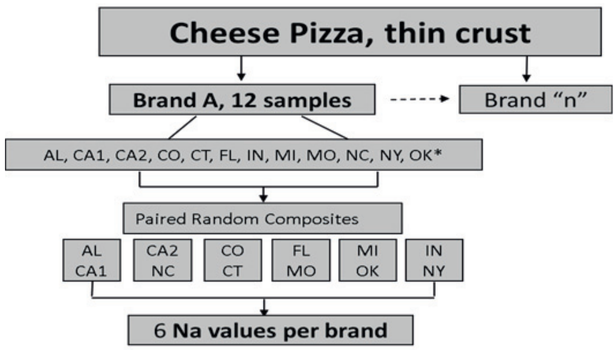


Fig.1. Sources of sodium data in the USDA National Nutrient Database for Standard Reference (SR25)

NFNAP, the analytical program supported by USDA and NIH, generates original analytical data for foods and dietary supplements sampled nationwide through a multi-stage probability sampling plan. NFNAP is guided by five specific aims as part of the overlying infrastructure. These include: 1) Identify key foods and critical nutrients; 2) Evaluate existing data quality; 3) Devise and implement a nationally-based sampling plan; 4) Analyze sampled foods using valid methods; and 5) Compile/disseminate representative estimates. Details on the different processes of NFNAP have been published by USDA researchers [6,7,8].

Figure 2 provides an example of the NFNAP sampling plan for obtaining nationwide samples of a popular processed food: frozen cheese pizza, thin crust. The specific description for the food being sampled in NFNAP has been determined based upon the product type reported in the national survey and frequency of consumption in WWEIA/NHANES as well as market sales volume. For example, pizza is a highly reported product type in the survey, and thin crust frozen cheese pizza has the highest sales volume compared to other types of pizza. Then, highly ranked brand names are identified for the food. For each brand, 12 sample units will be purchased: one unit (or more) in each of 12 state locations. The decision to composite the sample units into groups for analysis or not will be determined by the nutrient analysis plan, especially for sodium. For example, Figure 2 shows that 12 samples purchased for brand A were composited into six samples for the analysis of sodium to generate six sodium values. This would be repeated for Brand B, and so on for as many brands as were sampled.



*AL, Alabama; CA, California; CO, Colorado; CT, Connecticut; FL, Florida; IN, Indiana; MI, Michigan; MO, Missouri; NC, North Carolina; NY, New York; OK, Oklahoma

Fig.2. Model of sampling under NFNAP

2. Methods: Monitoring sodium in commercial packaged and restaurant foods

Dietary intake data from the national survey, WWEIA, NHANES 2007-2008, from about 9,100 individuals of all ages (excluding breast-fed infants) were used to identify major contributors of sodium. To prioritize which foods to analyze, approximately 125 foods, termed as Sentinel Foods, were identified to serve as indicators for assessment of change in the sodium content in the food supply. These were mainly commercially packaged and restaurant foods, selected based on evaluation of their sodium content, frequency of consumption, and potential for possible reduction in sodium content of the food.

The Sentinel Foods accounted for approximately 35% of total dietary sodium intake in WWEIA, NHANES 2007-2008; this project was led by the Food Surveys Research Group (FSRG) of ARS in close co-operation with NDL.

The process for monitoring the Sentinel Foods is conducted through nationwide sampling and analysis as follows. First, food samples are collected at retail outlets according to the NFNAP sampling plan described above. The samples are then shipped to labs at either Virginia Tech or Texas Tech (for meats and meat products) for preparation and compositing of samples. Aliquots are prepared from each composite and sent to analytical labs along with QC materials according to a work plan drawn up for each food at NDL. Inductively coupled plasma-atomic emission spectroscopy (ICP-AES), a well-recognized valid method for multi-element mineral analyses, is used to determine sodium concentrations. The coefficient of variability (CV%) for the analyses of duplicate samples of matrix-matched food materials by this method is less than 5%, at the concentrations seen in Sentinel Foods. After results are received from the labs, data are reviewed by a quality control panel at NDL; unacceptable results are referred back to the lab for explanation or repeat analysis. Acceptable values are entered into NDL's Nutrient Databank System where they are processed and ultimately released in SR.

Forty of the Sentinel Foods were identified and analyzed in 2010-11; an additional 60 foods were sampled and analyzed in 2012. Therefore, approximately 100 of the 125 Sentinel Foods have been analyzed under this project and the remainder will be analyzed in 2013. About 1200 other foods are being monitored at NDL using Nutrition Facts Panels of products and company website information, and consulting AC Nielsen market share data for brand selection and weighting. In addition, other selected foods including poultry, pork and seafood are being monitored using NFNAP protocols, due to recent changes in processing which add substantial sodium content. Foods analyzed since 2010 included poultry, pork and beef, beef frankfurters, fast food cheese, pepperoni, and sausage pizzas, white and wheat breads, unprepared dry mix macaroni and cheese, fast food tacos and quesadillas, and processed American cheese product.

3. Results and Discussion

Commercial packaged and restaurant foods are the focus of current efforts at NDL because high sodium concentrations and variability are intrinsic to this segment of the food supply. Even within food types, different brands have very different formulations and consequently, variable sodium concentrations. Statistical distribution shifts may occur when serving sizes differ, processing methods differ (e.g., oil vs. dry roasting of nuts), different sources of data exist for cooked and raw forms of the same food, and when variability is lower (e.g., when sodium samples are analyzed within the same lab using the same method).

Using macaroni and cheese as an example, figures 3, 4, and 5 address different facets of the considerable sodium variability which exists in commercially packaged and restaurant foods. Twelve samples of a popular national brand of boxed macaroni and cheese were procured and analyzed by the NDL's contract labs. The Nutrition Facts Panel on all sample packages showed 580 mg sodium per serving, recalculated by NDL to 829 mg sodium per 100 g of mix. Figure 3 shows that analytical results for the national brand sample units were consistently below the labeled value, with a mean value of 683 mg sodium/100 g. This is not surprising since many manufacturers are working to reduce sodium levels in their products and labeling regulations require the sodium value to be overestimated. The sodium reductions in many products are being made gradually (sometimes called "stealth" reductions), at about 5% per year, while the Nutrition Facts Panels may not reflect the recently lowered sodium values.

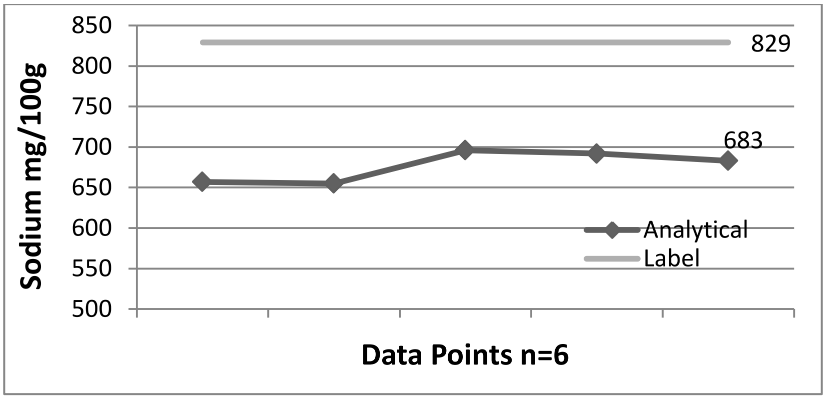


Fig.3. Macaroni and cheese boxed dry mix, unprepared Brand A: Sodium analytical vs. label values

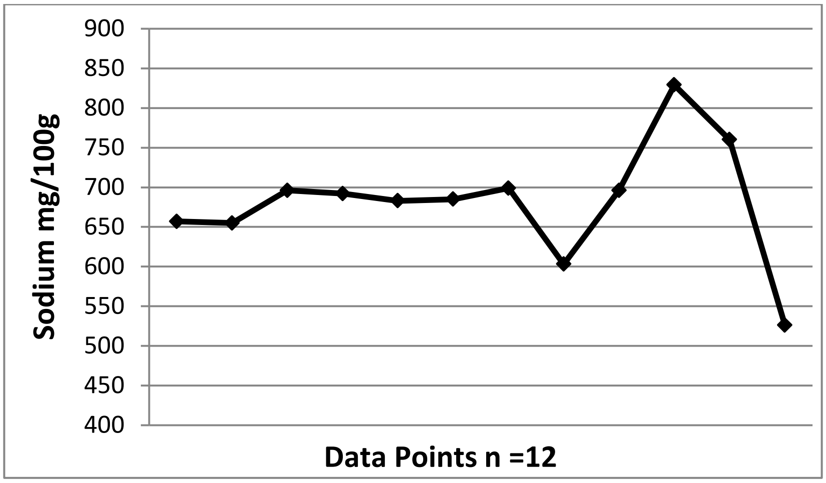


Fig.4. Macaroni and cheese boxed dry mix, unprepared Store Brands: Sodium variability

Figure 4 shows 12 samples of generic or store brands of macaroni and cheese dry mix that were purchased nationwide. Analyses of the 12 samples showed that seven of the 12 samples contained a similar amount of sodium, with a mean value of approximately 681 mg sodium/100 g dry mix. Sodium values for the five other analyses varied from the previous seven points, ranging from just above 500 mg/100g to almost 830 mg/100g. Overall, the mean value for the generic dry mix product was 682 mg sodium/100 g dry mix. However, the mean value may not reflect the actual value for any one product due to the variability among the products.

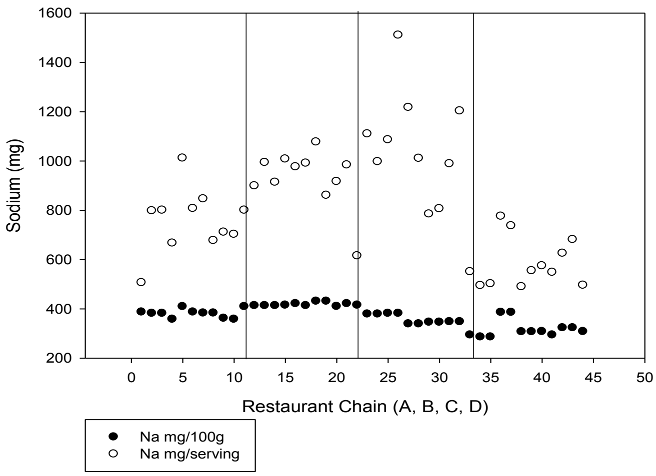


Fig.5. Children's macaroni and cheese in restaurants: Sodium per 100 g vs. per serving

Figure 5 shows the wide variability for macaroni and cheese as served in four national family-style restaurant chains. These sample units were selected from the children's menu. Analytical results for the 12 samples from each of the four chains showed means of 317, 380, 359, and 417 mg sodium/100 g. The overall mean for 48 values was 368 mg/100 g. Analytical values on a 100-gram basis are remarkably similar for key nutrients, including sodium. However, when the effect of portion size served was taken into account, the variability among the values for the four chains increased dramatically. The range of mean portion sizes was 184 g to 298 g.

Table 1 shows the sodium ranges in different cuts or parts of raw and cooked poultry, pork and beef, which have been subjected to different processing treatments. Enhancement (a common practice of injecting a brine solution into meat in order to introduce moisture and flavor) and canning (which usually introduces added sodium) increase the sodium concentration 2- to 3-fold, compared to meat and poultry items which have not been processed. At the present time, beef muscle meat is not usually treated by enhancement. Thus, the sodium content of beef cuts analyzed by NDL and its collaborators indicate levels below 100 mg/100 g of food. In contrast, processed products such as beef luncheon meat and frankfurters typically contain higher amounts of sodium because of their salt-containing formulations.

Table 1.Range of sodium values found in various meat products

Meat item	Sodium range (mg/100g)
Beef, lean and fat	40 - 90
Chicken or turkey, meat only	50 – 100
Chicken, boneless breast meat	~100
Chicken, boneless breast meat, enhanced	~350
Chicken or turkey, canned	250 – 500
Pork, fresh, non-enhanced, lean and fat	40 - 90
Pork, fresh, enhanced, lean and fat	150 - 240
Pork, cured, ham, lean and fat	700 - 1400

Table 2 shows sodium values for several highly consumed foods from four popular national family-style restaurant chains. The variability of sodium was evident in all seven foods sampled; four items (French fries, mozzarella sticks, steak and fried shrimp) were significantly different ($p<0.05$) between restaurant chains.

Table 2.Sodium in restaurant foods (4 chains) in mg sodium/100g (SD)

Food	A	B	C	D
French fries**	46 (29.9)	521 (88.4)	48 (10.6)	374 (193.6)
Chicken nuggets or tenders	656 (9.0)	555 (66.3)	684 (205.9)	524 (139.9)
Fried shrimp**	877 (61.6)	714 (26.1)	1136 (87.6)	685 (116.0)
Macaroni and cheese	317 (36.0)	380 (18.5)	359 (20.1)	417 (7.7)
Mozzarella sticks**	933 (25.3)	793 (50.2)	No sample	656 (25.6)
Steak**	349 (30.2)	549 (29.5)	134 (57.2)	194 (78.7)
Catfish	No sample	No sample	414 (72.4)	No sample

**significantly different among chains ($p<0.05$)

Table 3 shows sodium values in highly consumed seafood from three sources: a) SR22 data, from Agriculture Handbook No. 8, 1987; b) SR25 data, from NFNAP retail samples; and c) Data from National Fisheries Institute (NFI) untreated samples (freshly caught seafood not subjected to typical storage practices on fishing boats). The retail samples have much higher levels of sodium than earlier data, or than those found in the freshly caught untreated samples. According to NFI, during commercial processing of raw fish which is eventually sold in the retail market, sodium compounds may come into contact with the fish. The seafood may be stored in refrigerated seawater on the ship after catch, and they may be treated with sodium polyphosphate or similar compounds prior to freezing, to reduce the amount of liquid (drip) that is released when the frozen fish are thawed.

Table 3.Sodium in selected seafood (mg/100g)

Description	SR22	SR25 (retail samples)	SR25 (NFI* samples)	NFI individual values
Pacific cod	71	303	109	80, 72, 174
Walleye pollock	99	333	159	182, 146, 149
Sockeye salmon	47	112	71	129, 39, 44
Shrimp, mixed species	148	566	119	119, 115, 123

*freshly caught untreated samples

4. Conclusions

Many challenges exist for monitoring foods in the US food supply which, either due to concentration, quantities consumed or both contribute significantly to intake. The marketplace has become increasingly dynamic and complex. In addition, commercially prepared foods are becoming a much larger proportion of the US diet. Current analytical data for high ranking foods are essential for maintaining USDA's food composition databases. Research can address these challenges, but needs are great. Current market share data are costly. Nutrient profiles for restaurant foods are not widely available at the point of purchase. Observed variability in nutrient content and portion size among brands/chains must be considered. Often, data are difficult to obtain or unavailable, acquisition of accurate data is time-consuming, and websites may be inaccurate or out of date. The processes being used in growing, storing, shipping and marketing of various agricultural commodities, ingredients in processed foods, are diversifying and changing frequently. This could affect the overall processed packaged foods. Obtaining data based upon nationwide sampling is critical and, given the cost, funding is equally critical. Nonetheless, analyses of the majority of the highly consumed processed and prepared foods (~100 foods) were completed through 2012 and the remainder will be completed in 2013. These data are essential in supporting research as well as providing information to Americans for making healthy dietary choices.

Acknowledgements

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