# Relationships between Concentrations of Sodium, Potassium, and Chlorine in Unsalted Foods

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Instrumental neutron activation analysis was used to determine the concentrations of sodium, potassium, and chlorine in 167 samples of unsalted foods representing 112 different foods and 6 commercial beverages. The results of regression analysis show that the concentrations of chlorine in foods cannot be predicted accurately from the concentrations of sodium and potassium. Comparison of the results to those in published data bases shows excellent agreement for potassium; however, the data bases contain values of sodium and chlorine that are excessively high for some foods. The very low detection limits of neutron activation and the relative freedom from contamination make it an excellent technique for the simultaneous analysis of sodium, potassium, and chlorine in foods. Many of the values for chlorine reported here are the first published values for chlorine concentrations in food.

# INTRODUCTION

The concentration of chlorine in food is often assumed to be correlated with the concentration of sodium. This is a reasonable assumption when sodium chloride is a food additive, but the supporting evidence for this assumption in uncooked, unadulterated, primitive foods is equivocal. The primary evidence for the correlation of chlorine and sodium concentrations in food is based on a statistical analysis of the British nutrient data base (Paul and Southgate, 1978) that showed more than two-thirds of the overall variation of the chlorine concentration in unadulterated foods were linked to the sodium concentration (Yarbrough Al-Bander et al., 1988). The primary nutrient data base used in the United States, the *Composition of Foods* series, does not include data on the chlorine content of foods (USDA, 1976–1991).

Conclusions about the relationships between nutrients in food, based on statistical analysis of compiled nutrient data bases, are limited by inconsistencies inherent in such compilations. For example, the British data base is compiled from published sources that used a variety of analytical procedures to determine sodium and chlorine concentrations. The various elements were often determined by different investigators, and the values for sodium and chlorine were often determined on different samples. The values thus reflect interlaboratory biases and regional and seasonal differences in the composition of the food samples.

There is an increased need for an accurate data base for the chlorine concentration of foods because of the critical role of chlorine in the correction of hypokalemic alkalosis (Kassirer et al., 1965) and the role of the chloride ion as a determinant in sodium-dependent hypertension. Sodium appears to induce hypertension only in conjunction with the chloride anion (Whitescarver et al., 1984; Kurtz et al., 1987). Amelioration of hypertension by increased potassium intake has been suggested (Luft, 1989). The large data base for sodium and potassium concentrations in foods suggests that diets low in sodium tend to be high in potassium. These biological interactions among sodium, potassium, and chlorine make it important to have accurate data regarding their concentrations in foods.

Table I.	Concentrations	of Sodium,	Potassium, and
Chlorine	Determined in 1	NBS Referen	ice Materials*

	sodium, $\mu g g^{-1}$	potassium, $\mu g g^{-1}$	chlorine, µg g <sup>-1</sup>					
Orchard Leaves 1571								
NBS values	$82 \pm 6$	$14700 \pm 300$	700%					
this study	$86 \pm 5$	$14100 \pm 400$	$760 \pm 70$					
this study	$88 \pm 6$	$14500 \pm 500$	830 <b>±</b> 90					
	Bovine	e Liver 1577A						
NBS values	$2430 \pm 130$	$9960 \pm 70$	$2800 \pm 100$					
this study	$2400 \pm 30$	$10200 \pm 400$	$2750 \pm 90$					

<sup>a</sup> Analytical uncertainties for values determined in this study represent one standard deviation based on counting statistics. <sup>b</sup> Value is not certified.

The concentrations of sodium, potassium, and chlorine are difficult to determine in unadulterated foods because these elements, especially sodium and chlorine, are often present at very low concentrations and samples are susceptible to contamination during preparation for analysis. An investigation into the covariance of these elements in foods is done optimally if the element concentrations are determined simultaneously by the same analytical technique on single samples. Neutron activation analysis is an excellent method for the simultaneous determination of these three elements because the limits of detection are less than the microgram per gram level (DeSoete et al., 1972). The potential for contamination is minimized with neutron activation analysis because no sample pretreatments are required.

The objectives of this research are to determine the relationships between the concentrations of sodium, potassium, and chlorine in unadulterated and minimally processed foods; to demonstrate the applicability of neutron activation for the analysis of sodium, potassium, and chlorine in foods; and to extend the data base for the chlorine content in foods.

### EXPERIMENTAL PROCEDURES

Samples of food were purchased from local supermarkets. Most items represented major national brands. Salt-free products of processed foods, juices, etc., were included. Fruits, vegetables, and meats were fresh except dried beans, peas, etc. Foods representative of a typical diet and the major food groups were selected. A total of 167 samples representing 112 different foods and 6 commercial beverages were analyzed. A limited number

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Table II. Concentrations of Sodium, Potassium, and Chlorine in Unsalted Foods<sup>a</sup>

ford         code* $\mu$ mol g*1 $\pm l_{T}$ $\mu$ mol g*1 $\pm l_{T}$ $\mu$ mol g*1 $\pm l_{T}$ apple Gramy Smith         675         0.09         0.02         23         2         0.038         0.013           apple, Red Delovas         675         0.3         0.061         26         0.28         0.07           apple sets         882         0.13         0.011         68         2         0.28         0.16           apple sets         683         0.14         0.01         166         2         26.3         0.8           banana         683         0.12         0.01         106         2         26.3         0.8           banana         683         0.02         0.02         87         3         20.5         0.3           banana         683         0.12         0.01         106         20         3.0         0.2         29         0.3           banany period         0.02         0.02         830         50         3.3         0.3         0.2         29         0.2         0.2         0.2         0.2         0.2         0.2         0.2         0.2         0.2         0.2			sodium		potassium		chlorine	
apple Grany Suith         1675         0.07         0.02         100         100         101         001           apple Grany Suith         676         0.3         0.03         25         2         0.13         0.01           apple Grany Suith         677         0.088         0.007         15.0         0.6         0.031         0.008           apricots         682         0.15         0.01         64         3         0.16         0.022           banana         683         0.04         77         4         0.005         0.02           banana         683         0.02         0.07         7         3         0.09         0.04           banana         683         0.04         0.07         7         3         3.0.9         0.6           banana         663         0.02         0.02         67         3         3.0         0.0           banana         662         0.28         0.06         78         3         4.1         0.3           beana, Graen Marchenn         0.01         0.02         280         10         4.3         0.2           beana, graen         662         0.23         0.21         0.2 <th>food</th> <th>code<sup>b</sup></th> <th><math>\mu</math>mol g<sup>-1</sup></th> <th>±1σ</th> <th><math>\mu</math>mol <math>g^{-1}</math></th> <th>±1σ</th> <th><math>\mu</math>mol <math>g^{-1}</math></th> <th>±1σ</th>	food	code <sup>b</sup>	$\mu$ mol g <sup>-1</sup>	±1σ	$\mu$ mol $g^{-1}$	±1σ	$\mu$ mol $g^{-1}$	±1σ
apper, brainty Smith         573         0.16         0.02         33         2         0.038         0.07           apple, Bed Dulkows         677         0.068         0.007         15.0         0.6         0.011         0.02           apricots         682         0.15         0.01         68         3         0.16         0.02           apricots         682         0.02         0.01         72         4         0.00         0.02           apricots         682         0.02         0.02         187         3         20.5         0.8           banana         693         0.02         0.02         187         3         20.6         0.8           bates, Creat Northern         0.76         0.02         30         0.0         3.3         0.3           beans, Creat Northern         0.19         0.02         33         0.2         1.0         0.8           beans, Creat Northern         0.6         0.03         100         4         2.0         0.1           beans, Creat Northern         0.12         0.3         0.7         3.0         3.0         0.2           beans, Creat Northern         0.12         0.3         1.0		0.75	B	0.00	, 8 F0			
apple transfy Smith         612         0.02         23         2         0.05         0.05           applease         677         0.068         0.067         15.0         0.6         0.056         0.0056           apricota         662         0.04         68         0.04         77         2         27         1           brans         683         0.04         0.01         72         4         0.09         0.02           brans         683         0.04         0.07         7         3         30.0         0.6           brans, Great Northern         0.76         0.06         509         9         3.2         0.2           brans, Great Northern         0.76         0.06         509         9         3.2         0.2           brans, Great Northern         0.05         0.01         350         10         4         2.1         0.3           brans, Great Northern         0.65         0.01         3.03         0.3         0.2         0.2         0.1           brans, Great Northern         0.65         0.01         3.03         0.3         0.4         1.4         0.6         0.2           brans, Jinn         562	apple, Granny Smith	675	0.17	0.02	50	2	0.038	0.002
apple.ked Lelicous         672         0.38         0.03         25         2         0.28         0.075           apple.nice         672         0.05         0.01         1.60         0.5         0.01         0.60         0.055         0.015         0.015         0.015         0.005         0.01         1.2         4         0.065         0.02           approximation         683         0.64         0.7         7         2         2.7.5         1         1.7.5         0.02         0.02         0.02         0.03         0.03         0.03         0.03         0.03         0.03         0.04         0.04         0.04         0.05         0.03         0.03         0.03         0.03         0.03         0.03         0.03         0.03         0.03         0.03         0.03         0.04         1.0         0.02         0.01         0.03         0.03         0.03         0.03         0.03         0.03         0.03         0.03         0.03         0.04         1.0         0.05         0.03         0.04         1.03         0.03         0.04         1.03         0.03         0.04         1.03         0.03         0.04         1.03         0.03         0.04         1.04	apple, Granny Smith	675	0.09	0.02	23	2	0.1	0.1
appendice         677         0.083         0.067         15.0         0.5         0.051         0.022           banana         662         0.18         0.04         77         2         0.70         0.02           banana         663         0.11         0.01         108         2         26.3         1.8           banana         663         0.02         0.02         87         3         20.5         0.3           banana         663         0.02         0.02         87         3         20.5         0.3           bataley, period         0.01         0.02         600         9         3.3         0.3         0.6           bean, Great Northern         0.01         0.02         600         0.3         0.00         62         2.1         0.3           bean, Great Northern         662         0.03         0.00         63         2.1         0.3         0.2           bean, Great Northern         662         0.03         0.3         92         4         15.6         1.0           bean, Jinno         652         0.04         0.03         100         6         2.2         1.0         2.2         2.6         0.0 <td>apple, Red Delicous</td> <td>675</td> <td>0.3</td> <td>0.03</td> <td>26</td> <td>2</td> <td>0.28</td> <td>0.07</td>	apple, Red Delicous	675	0.3	0.03	26	2	0.28	0.07
apricota         682         0.15         0.01         68         3         0.16         0.02           bannan         693         0.03         0.01         105         2         27.1         1           bannan         693         0.02         0.02         87.3         3         30.9         0.6           bannan         693         0.02         0.02         87.3         3         30.9         0.6           bannan         693         0.02         0.02         87.3         30.9         0.6           bean, Great Northern         0.76         0.66         0.99         9         3.2         0.2           bean, Great Northern         0.62         0.33         100         6         23.1         0.3           bean, Strath         652         0.24         0.03         100         6         23.1         0.9           bean, Strath         652         0.24         0.33         100         6         23.1         0.9           bean, Strath         652         0.24         0.33         101         4.1         1.5         1.5           bean, Strath         77         2.4 <th0.3< th="">         0.3         2.6</th0.3<>	applesauce	677	0.068	0.007	15.0	0.6	0.051	0.008
apricita         682         0.08         0.01         72         4         0.09         0.02           barana         693         0.18         0.01         72         2         27.         1           barana         693         0.18         0.01         0.02         197         2         28.5         0.3           barana         693         0.12         0.09         0.04         509         9         3.2         0.2           beans, Creat Northern         0.76         0.06         6.09         9         3.2         0.2           beans, Great Northern         0.62         0.04         0.04         100         0         2.4         0.3           beans, finto         652         0.02         0.02         420         0         4.1         0.3           bean, finto         0.13         0.02         420         0.2         3.7         0.2           bear         0.14         0.7         0.3         94         4         16.4         0.8           bear         0.21         0.3         87         3         2.62         0.3           bear         11/2         2.7         2.8         0.3	apricots	682	0.15	0.01	68	3	0.16	0.02
banana         693         0.68         0.04         77         2         27.         1           banana         683         0.12         0.01         108         2         26.3         0.8           banan, creat         683         0.02         0.07         87         3         26.3         0.3           beans, Creat Northern         0.11         0.02         390         50         3.3         0.3           beans, Great Northern         0.11         0.02         390         50         3.3         0.4           beans, Great Northern         562         0.28         0.05         78         3         4.1         0.3           beans, Jina         562         0.16         0.01         100         7         2.0         0.1           beans, Jina         562         0.13         0.02         430         7         4.0         0.4         0.4         0.4         0.4         0.4         0.4         0.4         0.4         0.4         0.4         0.4         0.4         0.4         0.4         0.5         4         1.6         0.4         0.6         0.6         0.6         0.6         0.6         0.6         0.6         0.	apricots	682	0.08	0.01	72	4	0.09	0.02
benne         693         0.1         0.01         108         2         28.3         0.8           berley, perfed         11.2         1.99         0.07         70         3         20.5         0.3           berley, perfed         11.2         1.99         0.07         70         3         20.5         0.3           beam, Great Northern         0.09         0.04         410         20         3.0         0.2           beam, green         562         0.04         0.03         100         6         2.31         0.9           beam, freen         562         0.04         0.03         100         6         2.31         0.2           beam, freen         237         24.8         0.3         490         7         2.7         0.1           beef, round         247         25.4         0.3         811         4         16.0         0.8           beef, val liver         371         27.4         0.3         81         4         10.4         0.8           beef, val liver         371         27.4         0.3         81         4         10.4         0.8           beef, val liver         371         27.4 <td< td=""><td>banana</td><td>693</td><td>0.68</td><td>0.04</td><td>77</td><td>2</td><td>27.</td><td>1</td></td<>	banana	693	0.68	0.04	77	2	27.	1
beans         663         0.02         0.02         87         3         20.5         0.3           beas, Creat Northern         0.76         0.06         509         9         3.2         0.2           beas, Creat Northern         0.76         0.06         509         9         3.2         0.2           beas, Creat Northern         562         0.28         0.06         40         9         3.4         0.8           beas, Strate Northern         562         0.04         0.03         100         6         2.3         0.9           beas, Strate Northern         565         0.11         0.02         420         7         2.0         0.1           beas, Strate Northern         565         0.13         0.02         420         7         2.0         0.1           beas, Great Northern         574         16.7         0.2         88         3         2.4         0.6           beef, vall liver         371         2.4         0.3         84         4         10.1         0.8           broccoli         576         2.0         0.3         80         4         16.4         0.0           broccoli         576         32.0	banana	693	0.1	0.01	108	2	26.3	0.8
bates, pearled         11-2         1.99         0.07         70         3         30.9         0.6           beans, Great Northern         0.11         0.02         390         60         3.3         0.3           beans, Great Northern         562         0.24         0.03         100         6         4.1         0.02           beans, Jans         562         0.24         0.03         100         6         4.1         0.02           beans, Jans         565         0.11         0.02         420         20         3.7         0.2           beans, Jans         565         0.11         0.02         420         20         3.7         0.2           beaf         237         24.8         0.3         84         4         1.4.5         0.8           beaf         237         23.3         0.3         84         4         1.6.4         0.8           bears, Jersen litter         774         1.5.4         0.3         817         4         1.6.4         0.8           bears         1.01         0.2         2.8         0.3         4.7         0.3         0.2         0.9           broccoli         576         8.8 </td <td>banana</td> <td>693</td> <td>0.02</td> <td>0.02</td> <td>87</td> <td>3</td> <td>20.5</td> <td>0.3</td>	banana	693	0.02	0.02	87	3	20.5	0.3
beam, Great Northern         0.76         0.06         509         9         1.2         0.2           beam, Great Northern         0.09         0.04         410         20         3.0         0.2           beam, Great Northern         552         0.24         0.05         73         3         4.1         0.3           beam, Stream         552         0.14         0.03         100         6         2.11         0.9           beam, Stream         505         0.11         0.02         420         7         4.1         0.6           beam, Stream, pinto         505         0.13         0.02         420         20         3.7         0.2           beef         237         22.4         0.3         92         4         1.5.6         1           beef, val liver         371         27.7         0.3         77         3         24.2         0.5           broccoli         574         16.7         0.2         85         3         2.6         0.3           broccoli         575         22.0         0.3         90         4         1.6         0.6           broccoli         575         8.5         0.1         121	barley, pearled	11-2	1.99	0.07	70	3	30.9	0.6
beam, Great Northern         0.11         0.02         390         50         3.3         0.3           beam, Great Northern         662         0.28         0.06         78         3         4.1         0.3           beam, Great Northern         662         0.24         0.03         100         6         2.31         0.30           beam, Jinto         66         0.13         0.02         300         17         4.3         0.12           beer, spinto         66         0.13         0.02         40         3.7         0.2           beef, selliver         237         24.8         0.3         40         4         1.4.5         0.4           beef, selliver         371         2.7.7         0.3         77         3         2.4.2         0.9           braccoll         576         167         0.2         88         3         4.2.4         0.0           braccoll         576         8.7         0.5         8.4         1.0.1         0.3         0.1           carrots         587         3.92         0.02         40         3         0.3         0.1           carrots         587         1.52         0.4 <t< td=""><td>beans. Great Northern</td><td></td><td>0.76</td><td>0.06</td><td>509</td><td>9</td><td>3.2</td><td>0.2</td></t<>	beans. Great Northern		0.76	0.06	509	9	3.2	0.2
beams, Great Northerm         0.09         0.04         410         20         3.0         0.2           beams, green         652         0.04         0.03         100         6         23.1         0.9           beams, kinna         665         0.11         0.02         420         7         2.0         0.1           beams, linna         665         0.11         0.02         420         7         2.0         0.1           beams, linna         665         0.11         0.02         420         7         2.0         0.1           beams, linna         665         0.11         0.02         420         7         2.0         0.1           beams, linna         237         24.3         0.3         82         4         1.6.5         0.8           beef, veal liver         371         27.7         0.3         177         3         24.2         0.5           berecail         576         220         0.3         90         4         16.4         0.8           caurots, none garden         587         42.6         0.4         97         4         0.2         0.8           caurots, none garden         587         42.6	beans, Great Northern		0.11	0.02	390	50	3.3	0.3
beam, green         662         0.28         0.05         78         3         4.1         0.3           beam, strene         662         0.044         0.03         100         6         23.1         0.9           beams, linna         665         0.11         0.02         420         7         2.0         0.1           beams, linna         665         0.13         0.02         420         7         2.0         0.1           beams, linna         665         0.13         0.02         420         7         2.0         0.1           beams, linna         676         237         224         0.3         948         4         14.5         0.8           beams, linna         576         84         0.3         90         4         164         0.8           bear, spread         576         87.7         0.2         88         3         26.2         0.9           braccoli         576         88.7         0.5         84         4         10.1         0.8           carrots         carrots         587         42.2         0.4         84         30.4         0.3           cauliflower         591         1.1	beans, Great Northern		0.09	0.04	410	20	3.0	0.2
beans, streen         562         0.04         0.08         100         6         23.1         0.09           beans, lina         655         0.11         0.02         420         7         2.0         0.1           beans, jina         655         0.11         0.02         420         7         2.0         0.1           beef         237         24.8         0.3         92         4         13.6         1           beef, ground         247         25.4         0.3         81         4         14.5         0.8           beef, walliver         371         25.7         0.3         813         3         24.2         0.5           brocoli         576         887         0.5         84         4         10.6         0.8           brocoli         576         887         0.5         84         4         10.7         0.8         0.3	beans, green	562	0.28	0.05	78	3	41	0.3
beam, Hinny         Dot         0.05         0.01         350         10         4.9         0.2           beam, Hinn         565         0.11         0.02         420         7         2.0         0.1           beef,         237         23.3         0.3         94         4         16.5         1.           beef, veal liver         371         27.7         0.3         77         3         24.2         0.5           beet, veal liver         371         27.7         0.3         77         3         24.2         0.5           beet, veal liver         371         27.7         0.3         97         4         16.4         0.8           broccoil         376         22.0         0.3         90         4         16.4         0.8           broccoil         376         22.0         0.3         90.2         40         3         0.2         0.6           carrots         687         42.6         0.4         97         4         20.4         0.5           carrots         687         42.6         0.4         97         4         20.4         0.5           carots, hone gardien         587         42.6 <td>beans, green</td> <td>562</td> <td>0.04</td> <td>0.03</td> <td>100</td> <td>6</td> <td>23.1</td> <td>0.0</td>	beans, green	562	0.04	0.03	100	6	23.1	0.0
beans, Jina 565 0.11 0.02 420 7 2.0 0.1 beans, Jina 0.02 420 20 3.7 0.2 beef 237 24.8 0.3 92 4 15.6 1 beef, 237 24.8 0.3 92 4 15.6 1 beef, 237 24.8 0.3 94 4 14.5 0.8 beef, selliver 371 27.7 0.3 77 3 24.2 0.5 beef 4 15.7 0.2 88 3 26.2 0.9 broccoil 378 38. 0.5 84 4 16.1 0.8 broccoil 378 38. 0.5 84 4 10.1 0.8 broccoil 4 10.1 0.8 0.8 broccoil 4 10.1 0.8 0.8 broccoil 4 10.1 0.8 0.8 broccoil 578 38. 0.5 84 4 10.1 0.8 broccoil 587 31.92 0.02 40 3 10.2 0.8 carrots 587 31.92 0.02 40 3 10.2 0.8 carrots 687 31.92 0.02 40 3 10.2 0.8 carrots 687 31.92 0.02 40 3 10.2 0.8 carrots 687 31.92 0.02 40 3 10.2 0.8 carrots 699 0.08 0.02 85 3 3.8 0.4 cauliflower 691 11.1 0.2 68 3 4.7 0.3 calliflower 691 11.1 0.2 88 3 4.7 0.3 calliflower 891 11.1 0.2 88 3 4.7 0.3 celery 584 6.6 0.1 92 3 46.8 0.8 celery 584 6.8 0.1 92 3 46.8 0.8 celery 584 6.8 0.1 92 3 46.9 0.8 celery 699 0.08 0.01 82 2 0 0.14 0.02 celery 699 0.08 0.01 82 2 0 0.14 0.02 chicken, breast 316 27.7 0.3 83 4 15.3 0.5 chicken, breast 316 27.7 0.3 83 4 15.3 0.5 chicken, breast 316 27.7 0.3 81 3 19.8 0.5 chicken, breast 316 27.7 0.3 81 3 19.8 0.5 chicken, breast 316 27.7 0.3 81 3 19.8 0.5 chicken, breast 316 27.6 0.3 84 4 11.0 5 corrumber 877 0.28 0.03 44 3 9.9 0.3 0.2 cucumber 877 0.28 0.03 44 3 9.5 0.3 ceggplant 0.4 0.03 0.4 84 3 9.5 0.3 ceggplant 0.4 0.03 0.4 84 3 9.5 0.3 figh, can perch 438 3.3 0.4 72 4 3.4 0.4 figh, can perch 438 3.3 0.4 72 4 3.4 0.4 figh, heat perch 438 3.3 0.4 72 4 3.4 0.4 figh, can perch 438 3.3 0.4 72 4 3.4 0.4 figh, can perch 438 3.3 0.4 72 4 3.4 0.4 figh, can perch 438 3.3 0.4 72 4 3.4 0.4 figh, can perch 438 3.3 0.4 72 4 3.4 0.4 figh, can perch 438 3.3 0.4 72 4 3.4 0.4 figh, can perch 438 3.3 0.4 72 4 3.4 0.4 figh, can perch 438 3.3 0.4 72 4 3.4 0.4 0.4 figh, cen perch 438 3	beens kidney	001	0.05	0.00	350	10	10	0.0
Description         Dot         13         DOZ         400         20         57         0.2           beef         237         23.3         0.3         94         4         14.5         0.8           beef, veal liver         371         27.7         0.3         77         3         24.2         0.5           beets, veal liver         371         27.7         0.3         77         3         24.2         0.5           beets, veal liver         574         16.7         0.2         88         3         26.2         0.9           broccoli         576         22.0         0.3         90         4         16.4         0.8           Brueselis sprouts         578         8.8         0.1         72         2         5.8         0.3           carbage         584         0.82         0.04         84         3         1.01         0.8           cauliflower         591         1.3.9         0.2         21         1         4.6         1           celery         594         5         0.1         92         2         0.24         0.6           celery         594         5         0.1         92	beens lime	565	0.00	0.01	420	7	2.0	0.2
best         23         0.4         0.2         22         24         1.6         0.4           beef, pround         247         25.4         0.3         81         4         16.6         0.6           beef, sealliver         371         27.7         0.3         81         4         16.0         0.5           beets         574         16.7         0.2         88         3         26.2         0.9           broccoli         576         38.7         0.5         84         4         10.1         0.6           Brussels sprouts         576         38.7         0.5         84         4         10.1         0.6           carrots, home garden         584         0.62         0.04         84         3         4.3         0.1           carrots, home garden         587         42.6         0.4         97         4         20.4         0.3           califlower         591         4.03         0.02         88         3         3.8         0.4           califlower         594         6.6         0.1         92         3         45.9         0.6           califlower         594         0.6         0.1 <td>beens pinto</td> <td>000</td> <td>0.11</td> <td>0.02</td> <td>420</td> <td>20</td> <td>2.0</td> <td>0.1</td>	beens pinto	000	0.11	0.02	420	20	2.0	0.1
best         207         24.3         0.3         92         4         1.00         1.6           best pround         347         25.4         0.3         94         4         14.0         0.8           best pround         371         25.4         0.3         91         4         14.0         0.8           best pround         374         25.4         0.3         90         4         16.4         0.8           broccoli         576         8.8         0.1         72         2         5.8         0.3         0.1         0.8           cabbage         584         0.62         0.04         84         10.1         0.8           carrots         587         3.192         0.02         40         3         4.3         0.1           carrots         587         3.3         0.1         121         4         10.7         0.3           cauliflower         591         1.1.1         0.2         68         3         4.7         0.3           celery         594         6.6         0.1         92         3         46         1         0.6         0.4           celery         594         6.6 </td <td>beaf</td> <td>007</td> <td>0.10</td> <td>0.02</td> <td>420</td> <td>20</td> <td>0.7</td> <td>0.2</td>	beaf	007	0.10	0.02	420	20	0.7	0.2
peer         pround         247         25.4         0.3         Per         4         1.8.0         0.8           beer, stal liver         371         16.7         0.3         81         4         1.9.2         0.5           beroccoli         576         22.0         0.3         90         4         16.4         0.8           broccoli         576         38.7         0.5         84         4         10.1         0.8           broccoli         576         38.7         0.5         84         4         10.1         0.8           carrots         587         31.92         0.02         40         3         10.2         0.8           carrots         587         4.2.6         0.4         97         4         20.4         0.5           cauliflower         591         4.03         0.02         85         3         3.8         0.4           cauliflower         591         1.3.8         0.21         2.21         1         4.6         0.3           cauliflower         594         0.64         0.61         1.5         0.6         0.6         0.6         0.6         0.6         0.6         0.6	beel	207	24.0	0.3	92	4	10.0	1
bef, val         ist         is		207	20.0	0.3	94	4	14.0	0.8
Deets         57.1         27.7         0.3         77         3         24.2         0.5           brocccii         576         22.0         0.3         90         4         16.4         0.8           brocccii         576         22.0         0.3         90         4         16.4         0.8           Brusseis sprouts         578         8.6         0.1         72         2         5.8         0.3           carrots         587         3.1.62         0.4         497         3         10.2         0.5           carrots, home garden         587         4.2.5         0.4         497         3         10.2         0.5           cauliflower         591         1.1.1         0.2         68         3         4.7         0.3           cauliflower         591         1.3.9         0.2         21         1         4.6         0.3           celery         594         6.6         0.1         92         2         4.5.9         0.8           celery         594         6.6         0.3         83         4         15.1         0.5           chicken, heast         316         24.7         0.3	beel, ground	247	20.4	0.0	81	4	10.0	0.8
peeus         0.4         10.7         0.2         88         3         28.2         0.9           broccoli         576         38.7         0.5         84         4         10.1         0.8           Brusels sprouts         576         38.7         0.5         84         3         3.3         0.1           cartots         587         31.92         0.02         40         3         10.2         0.8           carrots, home garden         587         42.6         0.4         97         4         20.4         0.3           ceatrots, home garden         587         42.6         0.4         97         4         20.4         0.3           ceatrots         581         4.03         0.02         85         3         3.8         0.4           cealiflower         591         4.03         0.02         2         4.6         0.3           cetery         544         6.5         0.1         92         3         4         16.3         0.5           chicken, hyene         594         0.56         0.3         84         4         16.3         0.5           chicken, hyene         596         0.06         0.01	Deer, veal liver	371	27.7	0.3	77	3	24.2	0.5
procecui         o.ro.         22.0         0.3         90         4         16.4         0.8           Broeccii         576         38.7         0.5         84         4         10.1         0.8           Brusselis sprouts         578         8.8         0.1         72         2         5.8         0.3           cartots         587         3.192         0.02         40         3         10.2         0.8           carrots, home garden         587         5.3         0.1         121         4         10.7         0.3           cauliflower         591         11.1         0.2         68         3         4.7         0.3           celery         594         6.6         0.1         92         3         46         1           celery         594         6.6         0.1         92         2         45.9         0.8           cherries         699         0.09         0.02         62         2         0.14         0.02           chiken, thegat         316         25.6         0.3         84         4         16.3         0.5           chiken, thigh         317         27.5         0.3	Deets	574	10.7	0.2	88	3	26.2	0.9
processi Brussels sprouts         576         38.7         0.5         84         4         10.1         0.8           cabbage         564         0.62         0.04         84         3         4.3         0.1           carrots         587         42.6         0.4         97         4         20.4         0.5           carrots, home garden         587         42.6         0.4         97         4         20.4         0.5           cauliflower         591         4.03         0.02         85         3         3.8         0.4           cauliflower         591         1.1.1         0.2         68         3         4.7         0.3           celery         594         6.6         0.1         92         2         4.5         0.4           celery         594         6.6         0.1         92         2         4.5         0.4           cherits         699         0.90         0.02         62         2         0.2         1.4         0.02           cherits         1317         27.5         0.3         81         4         16.3         0.5           chiches, rhigh         317         27.5	Droccoll	576	22.0	0.3	90	4	16.4	0.8
Brussis sprouts         578         8.8         0.1         72         2         5.8         0.3           carbage         544         0.62         0.04         44         3         1.0.2         0.8           carrots         587         42.6         0.4         47         4         20.4         0.5           carrots, home garden         587         5.3         0.1         121         4         10.7         0.3           cauliflower         591         11.1         0.2         68         3         4.7         0.3           celery         594         6.6         0.1         92         2         45.9         0.8           celery         594         6.6         0.1         92         2         45.9         0.8           cherries         699         0.08         0.01         62         2         0.14         0.02           chicken, breast         316         25.6         0.3         84         4         15.3         0.5           chicken, high         317         27.5         0.3         81         3         19.8         0.5           chicken, high         317         26.9         0.4	broccoli	576	38.7	0.5	84	4	10.1	0.8
cabbage         584         0.62         0.04         84         3         4.3         0.1           carrots         587         31.92         0.02         40         3         10.2         0.8           carrots, home garden         587         42.6         0.4         97         4         20.4         0.5           carrots, home garden         587         42.6         0.4         97         4         20.4         0.5           cauliflower         591         13.9         0.02         85         3         3.8         0.4           celery         594         5         0.1         92         3         46         1           celery         594         5         0.1         92         2         45.9         0.8           chrisen, breast         316         24.7         0.3         83         4         15.3         0.5           chicken, high         317         27.5         0.3         81         3         18.5         0.6           corffe, instart, Folgers         872         9.1         0.3         1000         20         14         1           corffe, instart, Folgers         30.7         25.9	Brussels sprouts	578	8.8	0.1	72	2	5.8	0.3
carrots         587         31.92         0.02         40         3         10.2         0.8           carrots, home garden         587         5.3         0.1         121         4         10.7         0.3           cauliflower         591         1.1.1         0.2         68         3         4.7         0.3           cauliflower         591         13.9         0.2         21         1         4.6         0.3           celery         594         6.6         0.1         92         2         45.9         0.8           celery         594         6.6         0.1         92         2         45.9         0.8           cherries         699         0.08         0.01         62         2         0.14         0.02           chicken, breast         316         25.6         0.3         84         4         15.3         0.5           chicken, breast         316         25.6         0.3         81         3         19.8         0.5           chicken, breast         316         24.7         0.3         1000         20         14         1           corn, whole         0.03         0.009         37 <td>cabbage</td> <td>584</td> <td>0.62</td> <td>0.04</td> <td>84</td> <td>3</td> <td>4.3</td> <td>0.1</td>	cabbage	584	0.62	0.04	84	3	4.3	0.1
cerrots         587         42.6         0.4         97         4         20.4         0.5           cerrots         591         4.03         0.02         85         3         3.8         0.4           cauliflower         591         11.1         0.2         68         3         4.6         0.3           cealuiflower         591         13.9         0.2         21         1         4.6         0.3           celery         594         6.6         0.1         92         2         45.9         0.8           cherries         699         0.09         0.02         62         2         0.14         0.02           chicken, breast         316         24.7         0.3         83         4         15.3         0.5           chicken, high         317         26.9         0.4         84         4         18.5         0.6           corfle, instant, Folgers         872         9.1         0.3         1000         20         14         1           corn, whole         0.06         0.01         88         2         10.7         0.4           cornmeal         0.018         0.009         37         2	carrota	587	31.92	0.02	40	3	10.2	0.8
carrots, home garden         587         5.3         0.1         121         4         10.7         0.3           cauliflower         591         4.03         0.02         85         3         3.8         0.4           cauliflower         591         11.9         0.2         21         1         4.6         0.3           celery         594         6.6         0.1         92         2         45.9         0.8           cherries         699         0.09         0.02         62         2         0.24         0.06           chicken, breast         316         25.6         0.3         84         4         16.1         0.5           chicken, breast         316         24.7         0.3         83         4         15.3         0.5           chicken, breast         317         27.5         0.3         81         3         19.8         0.5           cornmeal         0.06         0.01         82         2         12.7         0.4           corn, whole         0.039         0.009         87         2         12.9         0.3           cornmeal         0.016         0.01         44         3         9	carrots	587	42.6	0.4	97	4	20.4	0.5
cauliflower         591         4.03         0.02         85         3         3.8         0.4           cauliflower         591         11.1         0.2         21         1         4.6         0.3           califlower         591         13.9         0.2         21         1         4.6         0.3           celery         594         6.6         0.1         92         3         4.6         1           celery         594         5         0.1         92         2         4.5.9         0.8           cherries         699         0.09         0.02         622         2         0.24         0.06           chicken, breast         316         24.7         0.3         83         4         15.3         0.5           chicken, high         317         27.5         0.3         81         3         19.8         0.5           corn, whole         0.066         0.01         88         2         10.7         0.4           corn, whole         0.03         0.01         47         2         12.9         0.3           cucumber         597         0.16         0.02         25.9         0.9         3	carrots, home garden	587	5.3	0.1	121	4	10.7	0.3
cauliflower         591         11.1         0.2         68         3         4.7         0.3           califlower         591         13.9         0.2         21         1         4.6         0.3           celery         594         6.6         0.1         92         2         4.59         0.8           cherries         699         0.09         0.02         62         2         0.24         0.06           chicken, breast         316         25.6         0.3         84         4         16.1         0.5           chicken, breast         316         24.7         0.3         81         3         19.8         0.5           chicken, high         317         26.9         0.4         84         4         18.5         0.6           corn, whole         0.039         0.009         82         2         12.8         0.4           cornmeal         0.018         0.009         37         2         12.6         0.4           cornmeal         0.016         0.02         25.9         0.9         3.3         0.2           cucumber         597         0.16         0.02         2.9         9.3         0.3	cauliflower	591	4.03	0.02	85	3	3.8	0.4
calliflower         591         13.9         0.2         21         1         4.6         0.3           celery         594         6.         0.1         92         3         46         1           celery         594         5         0.1         92         2         45.9         0.8           cherries         699         0.09         0.02         62         2         0.24         0.06           chicken, breast         316         25.6         0.3         84         4         16.1         0.5           chicken, breast         316         24.7         0.3         81         3         19.8         0.5           chicken, breast         317         26.9         0.4         84         4         18.5         0.6           corn, whole         0.06         0.01         88         2         10.7         0.4           corn, whole         0.039         0.009         82         2         12.6         0.4           cornmeal         0.03         0.01         47         2         12.9         0.3           cucumber         597         0.26         0.03         44         3         9.5         0.	cauliflower	591	11.1	0.2	68	3	4.7	0.3
celery         594         6.6         0.1         92         3         46         1           celery         594         5         0.1         92         2         45.9         0.8           cherries         699         0.09         0.02         62         2         0.24         0.06           chicken, breast         316         25.6         0.3         84         4         16.1         0.5           chicken, breast         316         24.7         0.3         83         4         15.3         0.5           chicken, thigh         317         27.5         0.3         81         3         19.8         0.5           chicken, thigh         317         27.5         0.3         81         1000         20         14         1           corn, whole         0.06         0.01         88         2         10.7         0.4           cornmeal         0.03         0.01         47         2         12.8         0.4           cornmeal         0.018         0.009         37         2         12.6         0.4           cuumber         597         0.16         0.02         25.9         0.9	cauliflower	591	13.9	0.2	21	1	4.6	0.3
celery         594         5         0.1         92         2         45.9         0.8           cherries         659         0.09         0.02         62         2         0.24         0.06           chicken, breast         316         24.7         0.3         84         4         16.1         0.5           chicken, breast         316         24.7         0.3         83         4         15.3         0.5           chicken, breast         316         24.7         0.3         83         4         18.5         0.6           corn, whole         317         27.5         0.3         81         3         19.8         0.5           corn, whole         0.06         0.1         88         2         10.7         0.4           corn, whole         0.039         0.009         82         2         12.8         0.4           cornmeal         0.038         0.01         47         2         12.6         0.4           cornmeal         0.33         0.2         2         8.0         0.3         0.2           cucumber         597         0.16         0.02         25.9         0.9         3.3         0.2	celery	594	6.6	0.1	92	3	46	1
cherrises         699         0.09         0.02         62         2         0.24         0.06           chicken, breast         316         25.6         0.3         84         4         16.1         0.02           chicken, breast         316         24.7         0.3         83         4         15.3         0.5           chicken, high         317         27.5         0.3         81         3         19.8         0.5           chicken, high         317         27.5         0.3         81         3         19.8         0.6           coffee, instant, Folgers         872         9.1         0.3         1000         20         14         1           corn, whole         0.039         0.009         82         2         12.8         0.4           cornmeal         0.018         0.009         37         2         12.6         0.4           cucumber         597         0.16         0.02         25.9         0.9         3.3         0.2           cucumber         597         0.26         0.03         44         3         9.5         0.3           eggplant         0.46         0.04         366         3	celerv	594	5	0.1	92	2	45.9	0.8
cherries         699         0.08         0.01         62         2         0.14         0.02           chicken, breast         316         25.6         0.3         84         4         16.1         0.5           chicken, breast         316         24.7         0.3         83         4         15.3         0.5           chicken, thigh         317         26.9         0.4         84         4         18.5         0.6           corn, whole         0.06         0.01         88         2         10.7         0.4           corn, whole         0.06         0.01         88         2         12.6         0.4           corn, whole         0.06         0.01         47         2         12.6         0.4           cornmeal         0.03         0.01         47         2         12.9         0.3           cucumber         597         0.16         0.02         25.9         0.9         3.3         0.2           cucumber         597         0.26         0.03         44         3         9.5         0.3           eggs, whole (6)         165         62.5         0.6         38         2         48         2<	cherries	699	0.09	0.02	62	2	0.24	0.06
chicken, breast         316         25.6         0.3         84         4         16.1         0.5           chicken, hreast         316         24.7         0.3         83         4         15.3         0.5           chicken, high         317         27.5         0.3         81         3         19.8         0.5           chicken, thigh         317         26.9         0.4         84         4         18.5         0.6           coffee, instant, Folgers         872         9.1         0.3         1000         20         14         1           corn, whole         0.06         0.01         88         2         10.7         0.4           cornmeal         0.018         0.009         37         2         12.6         0.4           cucumber         597         0.16         0.02         25.9         0.9         3.3         0.2           cucumber         597         0.26         0.03         44         3         9.5         0.3           eggplant         0.46         0.04         55         2         8.0         0.4           fish, ocean perch         438         38.3         0.4         72         4	cherries	699	0.08	0.01	62	$\overline{2}$	0.14	0.02
chicken, breast         316         24.7         0.3         83         4         15.3         0.5           chicken, thigh         317         27.5         0.3         81         3         19.8         0.5           chicken, thigh         317         27.5         0.3         81         3         19.8         0.5           chicken, thigh         317         26.9         0.4         84         4         18.5         0.6           corn, whole         0.06         0.01         88         2         10.7         0.4           corn, whole         0.03         0.009         82         2         12.8         0.4           cornmeal         0.03         0.01         47         2         12.9         0.3           cucumber         597         0.16         0.02         25.9         0.9         3.3         0.2           cucumber         597         0.26         0.03         44         3         9.5         0.3           cucumber         597         0.26         0.6         38         2         48         2           endive         598         17         0.3         66         3         12.4	chicken, breast	316	25.6	0.3	84	4	16.1	0.5
chicken, thigh       317       27.5       0.3       81       3       19.8       0.5         chicken, thigh       317       27.5       0.3       81       3       19.8       0.5         coffee, instant, Folgers       872       9.1       0.3       1000       20       14       1         corn, whole       0.06       0.01       88       2       10.7       0.4         corn, whole       0.039       0.009       37       2       12.6       0.4         cornmeal       0.018       0.009       37       2       12.6       0.4         cucumber       597       0.16       0.02       25.9       0.9       3.3       0.2         cucumber       597       0.26       0.03       44       3       9.5       0.3         eggplant       0.46       0.04       55       2       8.0       0.3         eggs, whole (6)       165       62.5       0.6       38       2       48       2         endive       598       17       0.3       66       3       12.4       0.6         fish, acean perch       438       34.3       0.4       72       4 <t< td=""><td>chicken, breast</td><td>316</td><td>24.7</td><td>0.3</td><td>83</td><td>4</td><td>15.3</td><td>0.5</td></t<>	chicken, breast	316	24.7	0.3	83	4	15.3	0.5
chicken, high       317       26.9       0.4       84       4       18.5       0.6         coffee, instant, Polgers       872       9.1       0.3       1000       20       14       1         corn, whole       0.06       0.01       88       2       10.7       0.4         corn, whole       0.039       0.009       82       2       12.6       0.4         corn, whole       0.03       0.01       47       2       12.9       0.3         cornmeal       0.03       0.01       47       2       12.9       0.3         cucumber       597       0.16       0.02       25.9       0.9       3.3       0.2         cucumber       597       0.26       0.03       44       3       9.5       0.3         eggs, whole (6)       165       62.5       0.6       38       2       48       2         endive       598       17       0.3       666       3       12.4       0.6         fish, cean perch       438       33.8       0.4       72       4       35.4       0.8         fish, cean perch       438       34.3       0.4       85       4	chicken thigh	317	27.5	0.3	81	3	10.0	0.5
Context, High         D.1         D.3         D.4         D.4         D.4         D.5         D.6           coffee, instant, Folgers         872         9.1         0.3         1000         20         14         1           corn, whole         0.039         0.009         82         2         12.8         0.4           corn, whole         0.038         0.011         47         2         12.6         0.4           cornmeal         0.018         0.009         37         2         12.6         0.4           cucumber         597         0.16         0.02         25.9         0.9         3.3         0.2           cucumber         597         0.26         0.03         44         3         9.5         0.3           eggplant         0.46         0.04         55         2         8.0         0.3           eggplant         0.46         0.3         66         3         12.4         0.6           fish, bacean perch         438         33.8         0.4         72         4         35.4         0.8           fish, pacean perch         438         34.3         0.4         85         4         28.3         0.9	chicken thigh	317	26.9	0.0	84	3	19.0	0.5
Corn, whole         012         0.1         0.3         1000         20         14         1           corn, whole         0.06         0.01         88         2         10.7         0.4           corn, whole         0.039         0.009         82         2         12.8         0.4           cornmeal         0.03         0.01         47         2         12.6         0.4           cornmeal         0.03         0.01         47         2         12.9         0.3           cucumber         597         0.16         0.02         25.9         0.9         3.3         0.2           cucumber         597         0.26         0.03         44         3         9.5         0.3           eggs, whole (6)         165         62.5         0.6         38         2         48         2           endive         598         17         0.3         66         3         12.4         0.6           fish, cean perch         438         33.8         0.4         72         4         35.4         0.8           fibur, white, unbleached         10         0.19         0.4         104         5         16.8         0.8 <td>coffee instant Folgers</td> <td>879</td> <td>20.J Q 1</td> <td>0.3</td> <td>1000</td> <td>20</td> <td>10.0</td> <td>0.0</td>	coffee instant Folgers	879	20.J Q 1	0.3	1000	20	10.0	0.0
Corn, whole         0.03         0.01         65         2         10.1         0.4           corn, whole         0.039         0.009         82         2         12.8         0.4           cornmeal         0.018         0.009         37         2         12.6         0.4           cornmeal         0.03         0.01         47         2         12.9         0.3           cucumber         597         0.26         0.03         44         3         9.5         0.3           eggplant         0.46         0.04         55         2         8.0         0.3           eggplant         0.46         0.04         55         2         8.0         0.3           eggplant         0.46         0.44         55         2         8.0         0.3           eggplant         20.1         0.3         66         3         12.4         0.6           fish, ocean perch         438         33.8         0.4         72         4         35.4         0.8           flour, white, unbleached         10         0.19         0.04         32         2         12.5         0.5           flour, whole wheat         9	corr whole	012	0.06	0.0	1000	20	14	1
Cornmeal         0.039         0.009         37         2         12.6         0.4           cornmeal         0.018         0.009         37         2         12.6         0.4           cornmeal         0.03         0.01         47         2         12.6         0.4           cucumber         597         0.16         0.02         25.9         0.9         3.3         0.2           cucumber         597         0.26         0.03         44         3         9.5         0.3           eggs, whole (6)         165         62.5         0.6         38         2         48         2           endive         598         17         0.3         66         3         12.4         0.6           fish, lake trout         20.1         0.3         59         3         15.3         0.4           fish, cean perch         438         34.3         0.4         85         4         28.3         0.9           fish, cocan perch         438         34.3         0.4         104         5         16.8         0.8           flour, white, unbleached         10         0.19         0.04         32         2         12.5	corn whole		0.00	0.01	00	2	10.7	0.4
commeal         0.015         0.009         37         2         1.2.6         0.4           cornmeal         0.03         0.01         47         2         12.9         0.3           cucumber         597         0.16         0.02         25.9         0.9         3.3         0.2           cucumber         597         0.26         0.03         44         3         9.5         0.3           eggs, whole (6)         165         62.5         0.6         38         2         48         2           endive         598         17         0.3         66         3         12.4         0.6           fish, cean perch         438         33.8         0.4         85         4         28.3         0.9           fish, cean perch         438         33.8         0.4         85         4         28.3         0.9           fish, rainbow trout         24.5         0.4         104         5         16.8         0.8           flour, white, bleached         10         0.19         0.04         32         2         12.5         0.5           flour, white, bleached         12         0.34         0.06         36         2 </td <td>corn, whole</td> <td></td> <td>0.035</td> <td>0.009</td> <td>02 97</td> <td>2</td> <td>12.0</td> <td>0.4</td>	corn, whole		0.035	0.009	02 97	2	12.0	0.4
corumber         597         0.03         0.01         47         2         12.9         0.3           cucumber         597         0.26         0.03         44         3         9.5         0.3           egg, whole (6)         165         62.5         0.6         38         2         8.0         0.3           egg, whole (6)         165         62.5         0.6         38         2         48         2           endive         598         17         0.3         66         3         12.4         0.6           fish, ocean perch         438         33.8         0.4         72         4         35.4         0.8           fish, ocean perch         438         34.3         0.4         85         4         28.3         0.9           fish, rainbow trout         24.5         0.4         104         5         16.8         0.8           flour, white, unbleached         10         0.19         0.04         32         2         12.5         0.5           flour, whole wheat         9         0.72         0.08         105         5         16.0         0.8           grape, red         737         1.36         0.0	commeal		0.018	0.009	01 47	2	12.0	0.4
cucumber         597         0.16         0.02         25.9         0.9         3.3         0.2           cucumber         597         0.26         0.03         44         3         9.5         0.3           eggplant         0.46         0.04         55         2         8.0         0.3           eggs, whole (6)         165         62.5         0.6         38         2         48         2           endive         598         17         0.3         666         3         15.3         0.4           fish, ocean perch         438         33.4         0.4         85         4         28.3         0.9           fish, ocean perch         438         33.4         0.4         85         4         28.3         0.9           fish, reinbow trout         24.5         0.4         104         5         16.8         0.8           flour, while, bleached         12         0.34         0.06         36         2         25.9         0.5           flour, whole wheat         9         0.72         0.08         105         5         16.0         0.8           grape, red         737         1.36         0.07         82 </td <td>commean</td> <td>507</td> <td>0.03</td> <td>0.01</td> <td>4/</td> <td>ž</td> <td>12.9</td> <td>0.3</td>	commean	507	0.03	0.01	4/	ž	12.9	0.3
cucumber         597         0.26         0.03         44         3         9.5         0.3           eggplant         0.46         0.04         55         2         8.0         0.3           eggs, whole (6)         165         62.5         0.6         38         2         48         2           endive         598         17         0.3         66         3         12.4         0.6           fish, rainbow trout         20.1         0.3         59         3         15.3         0.4           fish, rainbow trout         20.1         0.3         66         3         12.4         0.6           fish, rainbow trout         24.5         0.4         72         4         35.4         0.8           flour, white, unbleached         10         0.19         0.04         32         2         12.5         0.5           flour, whole wheat         9         0.72         0.08         105         5         16.0         0.8           grape, red         737         1.36         0.05         82         5         1.24         0.08           grape, red         737         1.36         0.02         23         1         1.4	cucumper	597	0.16	0.02	25.9	0.9	3.3	0.2
eggs whole (6)         165         62.5         0.6         38         2         8.0         0.3           eggs, whole (6)         165         62.5         0.6         38         2         48         2           endive         598         17         0.3         66         3         12.4         0.6           fish, ocean perch         438         33.8         0.4         72         4         35.4         0.8           fish, ocean perch         438         34.3         0.4         85         4         28.3         0.9           fish, ocean perch         438         34.3         0.4         85         4         28.3         0.9           fish, ocean perch         438         34.3         0.4         85         4         28.3         0.9           filour, white, bleached         10         0.19         0.04         32         2         12.5         0.5           flour, whole wheat         9         0.72         0.08         105         5         16.0         0.8           garlic         8.3         0.1         144         5         18.0         0.4           grape, red         737         1.36	cucumber	597	0.26	0.03	44	3	9.5	0.3
eggs, Whole (b)         155         62.5         0.6         38         2         48         2           endive         598         17         0.3         66         3         12.4         0.6           fish, lake trout         20.1         0.3         59         3         15.3         0.4           fish, cean perch         438         33.8         0.4         72         4         35.4         0.8           fish, rainbow trout         24.5         0.4         104         5         16.8         0.8           flour, white, unbleached         10         0.19         0.04         32         2         12.5         0.5           flour, whole wheat         9         0.72         0.08         105         5         16.0         0.8           grape, red         737         1.36         0.05         82         4         16.1         0.6           grape, red         737         1.36         0.05         82         5         1.24         0.08           grape, red         737         1.36         0.05         82         5         1.24         0.08           grape, red         737         0.36         0.02 <t< td=""><td>eggplant</td><td>1.05</td><td>0.46</td><td>0.04</td><td>55</td><td>2</td><td>8.0</td><td>0.3</td></t<>	eggplant	1.05	0.46	0.04	55	2	8.0	0.3
endive         598         17         0.3         66         3         12.4         0.6           fish, lake trout         20.1         0.3         59         3         15.3         0.4           fish, ocean perch         438         33.8         0.4         72         4         35.4         0.8           fish, ocean perch         438         34.3         0.4         85         4         28.3         0.9           fish, rainbow trout         24.5         0.4         104         5         16.8         0.8           flour, white, unbleached         10         0.19         0.04         32         2         12.5         0.5           flour, whole wheat         9         0.72         0.08         105         5         16.0         0.8           graic         8.3         0.1         144         5         18.0         0.4           grape, red         737         1.36         0.05         82         5         1.24         0.08           grape, Thompson         738         0.64         0.03         62         2         1.0         0.1           juice, cranberry         0.56         0.03         4.4         0.2	eggs, whole (6)	165	62.5	0.6	38	2	48	2
thish, lake trout       20.1       0.3       59       3       15.3       0.4         fish, ocean perch       438       33.8       0.4       72       4       35.4       0.8         fish, ocean perch       438       34.3       0.4       85       4       28.3       0.9         fish, rainbow trout       24.5       0.4       104       5       16.8       0.8         flour, white, ubleached       10       0.19       0.04       32       2       12.5       0.5         flour, whole wheat       9       0.72       0.08       105       5       16.0       0.8         flour, whole wheat       9       0.54       0.07       82       4       16.1       0.6         grape, red       737       1.36       0.05       82       5       1.24       0.08         grape, Thompson       738       0.64       0.03       62       2       1.0       0.1         grape fruit       740       0.32       0.02       54       3       1.1       0.1         juice, apple       2.02       0.05       28.4       0.7       .1       1.4       0.2         juice, cranberry       0.	endive	598	17	0.3	66	3	12.4	0.6
then, ocean perch       438       33.8       0.4       72       4       35.4       0.8         fish, ocean perch       438       34.3       0.4       85       4       28.3       0.9         fish, rainbow trout       24.5       0.4       104       5       16.8       0.8         flour, white, unbleached       10       0.19       0.04       32       2       12.5       0.5         flour, whole wheat       9       0.72       0.08       105       5       16.0       0.8         flour, whole wheat       9       0.72       0.08       105       5       16.0       0.8         garlic       8.3       0.1       144       5       18.0       0.4         grape, red       737       1.36       0.05       82       5       1.24       0.08         grape, Thompson       738       0.64       0.03       62       2       1.0       0.1         juice, cranberry       2.02       0.05       28.4       0.7       0.1       0.1         juice, grape       0.51       0.02       23       1       1.4       0.2         juice, grape       0.69       0.04       35.7 <td>rish, lake trout</td> <td></td> <td>20.1</td> <td>0.3</td> <td>59</td> <td>3</td> <td>15.3</td> <td>0.4</td>	rish, lake trout		20.1	0.3	59	3	15.3	0.4
fish, ocean perch       438       34.3       0.4       85       4       28.3       0.9         fish, rainbow trout       24.5       0.4       104       5       16.8       0.8         flour, white, ubleached       10       0.19       0.04       32       2       12.5       0.5         flour, white, ubleached       12       0.34       0.06       36       2       25.9       0.5         flour, whole wheat       9       0.72       0.08       105       5       16.0       0.8         garlic       8.3       0.1       144       5       18.0       0.4         grape, red       737       1.36       0.05       82       5       1.24       0.08         grape, Thompson       738       0.64       0.03       62       2       1.0       0.1         grapefruit       740       0.32       0.02       54       3       1.1       0.1         juice, apple       2.02       0.05       28.4       0.7           juice, cranberry       0.72       0.02       4.9       0.4       0.74       0.70         juice, cranberry       0.51       0.03       5	fish, ocean perch	438	33.8	0.4	72	4	35.4	0.8
fish, rainbow trout       24.5       0.4       104       5       16.8       0.8         flour, white, unbleached       10       0.19       0.04       32       2       12.5       0.5         flour, white, bleached       12       0.34       0.06       36       2       25.9       0.5         flour, whole wheat       9       0.72       0.08       105       5       16.0       0.8         flour, whole wheat       9       0.54       0.07       82       4       16.1       0.6         grape, red       737       1.36       0.05       82       5       1.24       0.08         grape, Thompson       738       0.64       0.03       62       2       1.0       0.1         grape, Thompson       738       0.64       0.03       62       2       1.0       0.1         grape ruit       740       0.32       0.02       54       3       1.1       0.1         juice, apple       2.02       0.05       28.4       0.7            juice, cranberry       0.51       0.03       5.4       0.6       0.7       0.1         juice, grape	fish, ocean perch	438	34.3	0.4	85	4	28.3	0. <b>9</b>
flour, white, unbleached       10       0.19       0.04       32       2       12.5       0.5         flour, white, bleached       12       0.34       0.06       36       2       25.9       0.5         flour, whole wheat       9       0.72       0.08       105       5       16.0       0.8         flour, whole wheat       9       0.72       0.08       105       5       16.0       0.8         grapt, whole wheat       9       0.72       0.08       105       5       16.0       0.8         grapt, whole wheat       9       0.72       0.08       105       5       16.0       0.8         grape, red       737       1.36       0.05       82       5       1.24       0.08         grape, red       737       1.36       0.02       54       3       1.1       0.1         grape Truit       740       0.32       0.02       54       3       1.1       0.1         juice, apple       2.02       0.05       28.4       0.7       0.7       juice, cranberry       0.72       0.02       4.9       0.4       0.74       0.07         juice, cranberry       0.51       0.03	fish, rainbow trout		24.5	0.4	104	5	16.8	0.8
flour, white, bleached       12       0.34       0.06       36       2       25.9       0.5         flour, whole wheat       9       0.72       0.08       105       5       16.0       0.8         garlic       83       0.1       144       5       18.0       0.4         grape, red       737       1.36       0.05       82       5       1.24       0.08         grape, Thompson       738       0.64       0.03       62       2       1.0       0.1         grapefruit       740       0.32       0.02       54       3       1.1       0.1         juice, apple       2.02       0.05       28.4       0.7            juice, cranberry       0.56       0.03       4.4       0.2             juice, cranberry       0.56       0.03       4.4       0.2             juice, grape       0.51       0.02       2.3       1       1.4       0.07          juice, grape       0.51       0.03       5.4       0.6       0.7       0.1	flour, white, unbleached	10	0.19	0.04	32	2	12.5	0.5
flour, whole wheat       9       0.72       0.08       105       5       16.0       0.8         flour, whole wheat       9       0.54       0.07       82       4       16.1       0.6         garlic       8.3       0.1       144       5       18.0       0.4         grape, red       737       1.36       0.05       82       5       1.24       0.08         grape, red       737       1.36       0.02       54       3       1.1       0.1         grape, red       737       1.36       0.02       54       3       1.1       0.1         grapefruit       740       0.32       0.02       54       3       1.1       0.1         juice, apple       2.02       0.05       28.4       0.7       0.1         juice, cranberry       0.56       0.03       4.4       0.2       0.1         juice, cranberry       0.51       0.03       5.4       0.6       0.7       0.1         juice, grape       0.69       0.04       35.7       0.9       1       1.21       0.07         juice, grape       0.64       0.03       27       1       0.62       0.08	flour, white, bleached	12	0.34	0.06	36	2	25.9	0.5
flour, whole wheat       9       0.54       0.07       82       4       16.1       0.6         garlic       8.3       0.1       144       5       18.0       0.4         grape, red       737       1.36       0.05       82       5       1.24       0.08         grape, red       737       1.36       0.03       62       2       1.0       0.1         grape, Thompson       738       0.64       0.03       62       2       1.0       0.1         grape, rul       740       0.32       0.02       54       3       1.1       0.1         juice, apple       2.02       0.05       28.4       0.7       0.1         juice, apple       2.61       0.02       23       1       1.4       0.2         juice, cranberry       0.56       0.03       4.4       0.2	flour, whole wheat	9	0.72	0.08	105	5	16.0	0.8
garlic8.30.1144518.00.4grape, red7371.360.058251.240.08grape, Thompson7380.640.036221.00.1grapefruit7400.320.025431.10.1juice, apple2.020.0528.40.71.40.2juice, cranberry0.560.034.40.21.40.2juice, cranberry0.560.034.40.21.40.7juice, grape0.510.035.40.60.70.1juice, grape0.690.0435.70.91.10.660.1juice, grape0.640.032710.620.081.10.07juice, grape0.640.033211.210.071.240.07juice, grape0.640.032710.620.081.240.07juice, orange drink, Hi-C0.970.0210.80.312.40.1juice, orange, 100% nat8851.750.054.312.40.1juice, prane2.740.074.80.70.70.1	flour, whole wheat	9	0.54	0.07	82	4	16.1	0.6
grape, red         737         1.36         0.05         82         5         1.24         0.08           grape, Thompson         738         0.64         0.03         62         2         1.0         0.1           grapefruit         740         0.32         0.02         54         3         1.1         0.1           juice, apple         2.02         0.05         28.4         0.7	garlic		8.3	0.1	144	5	18.0	0.4
grape, Thompson7380.640.036221.00.1grapefruit7400.320.025431.10.1juice, apple2.020.0528.40.7juice, apple2.610.022311.40.2juice, cranberry0.560.034.40.2juice, cranberry0.720.024.90.40.740.07juice, cranberry0.510.035.40.60.70.1juice, grape0.870.052810.60.1juice, grape0.640.032710.620.08juice, grape0.640.033211.210.07juice, orange drink, Hi-C0.970.0210.80.3juice, orange, 100% nat8851.750.054312.40.1juice, prane0.710.024.310.970.05juice, orange, from conc0.710.024.80.70.70.1	grape, red	737	1.36	0.05	82	5	1.24	0.08
grapefruit7400.320.025431.10.1juice, apple2.020.0528.40.7juice, apple2.610.022311.40.2juice, cranberry0.560.034.40.2juice, cranberry0.720.024.90.40.740.07juice, cranberry0.510.035.40.60.70.1<	grape, Thompson	738	0.64	0.03	62	2	1.0	0.1
juice, apple2.020.0528.40.7juice, apple2.610.022311.40.2juice, cranberry0.560.034.40.2juice, cranberry0.720.024.90.40.740.07juice, cranberry0.510.035.40.60.70.1juice, grape0.870.052810.60.1juice, grape0.640.032710.620.08juice, grape0.640.033211.210.07juice, orange drink, Hi-C0.970.0210.80.3juice, orange, 100% nat8851.750.054312.40.1juice, orange, from conc0.710.024.310.970.05juice, prane0.10.970.05juice, prane2.740.074.80.70.70.10.1	grapefruit	740	0.32	0.02	54	3	1.1	0.1
juice, apple2.610.022311.40.2juice, cranberry0.560.034.40.2juice, cranberry0.720.024.90.40.740.07juice, cranberry0.510.035.40.60.70.1juice, grape0.870.052810.60.1juice, grape0.690.0435.70.9juice, grape0.640.032710.620.08juice, grapefruit8790.430.033211.210.07juice, orange, 100% nat8851.750.054312.40.1juice, prane0.710.024.310.970.05juice, prane0.710.024.80.70.70.1	juice, apple		2.02	0.05	28.4	0.7		
juice, cranberry0.560.034.40.2juice, cranberry0.720.024.90.40.740.07juice, cranberry0.510.035.40.60.70.1juice, grape0.870.052810.60.1juice, grape0.690.0435.70.90.9juice, grape0.640.032710.620.08juice, grapefruit8790.430.033211.210.07juice, orange drink, Hi-C0.970.0210.80.312.40.1juice, orange, from conc0.710.024310.970.05juice, prune2.740.074.80.70.70.1	juice, apple		2.61	0.02	23	1	1.4	0.2
juice, cranberry0.720.024.90.40.740.07juice, cranberry0.510.035.40.60.70.1juice, grape0.870.052810.60.1juice, grape0.690.0435.70.9juice, grape0.640.032710.620.08juice, grapefruit8790.430.033211.210.07juice, orange drink, Hi-C0.970.0210.80.3juice, orange, 100% nat8851.750.054312.40.1juice, orange, from conc0.710.024.80.70.70.05juice, prune2.740.074.80.70.70.1	juice, cranberry		0.56	0.03	4.4	0.2		
juice, cranberry0.510.035.40.60.70.1juice, grape0.870.052810.60.1juice, grape0.690.0435.70.9juice, grape0.640.032710.620.08juice, grapefruit8790.430.033211.210.07juice, orange drink, Hi-C0.970.0210.80.3juice, orange, 100% nat8851.750.054312.40.1juice, prane0.710.024310.970.05juice, prane2.740.074.80.70.70.1	juice, cranberry		0.72	0.02	4.9	0.4	0.74	0.07
juice, grape0.870.052810.60.1juice, grape0.690.0435.70.9juice, grape0.640.032710.620.08juice, grapefruit8790.430.033211.210.07juice, orange drink, Hi-C0.970.0210.80.3juice, orange, 100% nat8851.750.054312.40.1juice, orange, from conc0.710.024.80.70.70.1	juice, cranberry		0.51	0.03	5.4	0.6	0.7	0.1
juice, grape0.690.0435.70.9juice, grape0.640.032710.620.08juice, grapefruit8790.430.033211.210.07juice, orange drink, Hi-C0.970.0210.80.312.40.1juice, orange, 100% nat8851.750.054312.40.1juice, orange, from conc0.710.024.80.70.70.1	juice, grape		0.87	0.05	28	1	0.6	0.1
juice, grape0.640.032710.620.08juice, grapefruit8790.430.033211.210.07juice, orange drink, Hi-C0.970.0210.80.3juice, orange, 100% nat8851.750.054312.40.1juice, orange, from conc0.710.024310.970.05juice, prune2.740.074.80.70.70.1	juice, grape		0.69	0.04	35.7	0.9		
juice, grapefruit8790.430.033211.210.07juice, orange drink, Hi-C0.970.0210.80.3juice, orange, 100% nat8851.750.054312.40.1juice, orange, from conc0.710.024310.970.05juice, prune2.740.074.80.70.70.1	juice, grape		0.64	0.03	27	1	0.62	0.08
juice, orange drink, Hi-C0.970.0210.80.3juice, orange, 100% nat8851.750.054312.40.1juice, orange, from conc0.710.024310.970.05juice, prune2.740.074.80.70.70.1	juice, grapefruit	879	0.43	0.03	32	1	1.21	0.07
juice, orange, 100% nat8851.750.054312.40.1juice, orange, from conc0.710.024310.970.05juice, prune2.740.074.80.70.70.1	juice, orange drink, Hi-C		0.97	0.02	10.8	0.3		
juice, orange, from conc0.710.024310.970.05juice, prune2.740.074.80.70.70.1	juice, orange, 100% nat	885	1.75	0.05	43	1	2.4	0.1
juice, prune 2.74 0.07 4.8 0.7 0.7 0.1	juice, orange, from conc		0.71	0.02	43	1	0.97	0.05
	juice, prune		2.74	0.07	4.8	0.7	0.7	0.1

# Table II (Continued)

		sodium		potassium		chlorine	
food	code <sup>b</sup>	$\mu$ mol $g^{-1}$	$\pm 1\sigma$	$\mu$ mol $g^{-1}$	$\pm 1\sigma$	$\mu$ mol $g^{-1}$	±10
		£ 1	0.1	50		15.0	0.4
juice, tomato		0.1 9 B	0.1	00 61	2	15.2	0.4
kashi breakfest careal		17	0.1	87	5	18	1
kiwi		0.72	0.05	82	š	13.9	0.4
lettuce, green leaf	606	8.2	0.2	57	2	16.2	0.4
lettuce, iceberg	606	3.0	0.1	172	6	39	2
lettuce, red leaf	606	8.4	0.2	62	3	32.6	0.6
lettuce, romaine	606	4.71	0.01	134	3	26.8	0.5
macaroni	11-53	0.55	0.08	59	3	14.6	0.6
melon, cantaloupe	762	8.0	0.1	70	2	5.8	0.2
melon, honeydew	764	4.9	0.1	61	2	10.2	0.4
milk, human, 6 months	138	3.93	0.09	11.0	0.9	8.3	0.5
milk, skim	131	16.7	0.3	35	2		
milk, skim	131	17.1	0.2	40	2	27.3	0.5
milk, 2%	104	17.7	0.3	41	3	28.2	0.5
milk, whole	124	10.2	0.2	37	1	94.1	0.8
milk, whole	124	16.1	0.2	36	2	24.1	0.0
musbroom select w/stem	609	1 48	0.2	101	6	16.2	0.4
mushrooms white	609	1.71	0.07	101	š	31.8	0.9
nuta, almonda	822	0.23	0.04	163	6	1.5	0.2
nuta, peanuta	835	0.27	0.06	168	6	2.4	0.2
nuts, pecans		0.6	0.1	87	5	3.6	0.6
nuts, walnuts	83 <del>9</del>	2.6	0.1	8 <del>9</del>	4	7.1	0.2
oat bran		0.875	0.001	119	5	8.9	0.6
oat bran		0.98	0.09	117	5	10.3	0.5
oatmeal	17	0.7	0.1	98	5	11	1
oatmeal	17	0.86	0.08	89	4	10.0	0.6
oats, whole grain		1.1	0.1	100	4	17.8	0.6
oats, whole grain		1.9	0.1	82	4	8.6	0.6
okra	612	1.00	0.08	69	3	20.6	0.7
onion, green	616	8.8	0.2	66	4	17.7	0.5
onion, green	616	8.8 1 1	0.1	31	2	10.8	0.8
onion, yellow	013	1.1	0.2	44	1	4.0	0.3
orange	779	0.015	0.000	41	2 1	0.71	0.04
nerslev	617	38.0	0.02	157	5	43	1
neech	779	0.24	0.4	90	2	1 23	0.07
peach	779	0.032	0.008	43	ī	0.30	0.04
pear	785	0.14	0.02	43	3	0.20	0.06
pear	785	0.13	0.02	27.8	0.9	0.05	0.01
peas, black-eyed		0.51	0.05	310	20	3.4	0.1
peas, split	628	0.77	0.07	270	10	12.8	0.3
peas, split	628	0.83	0.08	234	5	13.7	0.3
peas, split	628	1.03	0.08	260	10	16.4	0.3
pepper, green	634	0.073	0.007	7.6	0.6	1.5	0.1
pepper, green, home garden	634	0.07	0.01	39	2	1.7	0.2
plum	793	0.006	0.006	30	1	0.16	0.02
plum, Grand Rosa	793	0.01	0.01	48	3	0.8	0.1
popcorn nonk dank	202	0.04	0.02	73	3	11	0.6
pork, uark	303	20.3	0.4	90	4	11 9	<u>,</u> 0
pora, nghu	639	0.53	0.04	106	3	23	1
potato, red	639	3.1	0.1	109	3	20.5	0.5
potato, red	639	2.83	0.09	110	3	26.8	0.7
potato, Russet, w/o skin	639	0.364	0.009	91	5	3.6	0.3
potato, Russet, w/o skin	639	0.26	0.04	69	4	5.7	0.3
potato, white, home garden	639	0.11	0.02	132	4	7.6	0.2
pumpkin, canned	653	0.14	0.02	53	2	2.2	0.2
radish	654	2.16	0.09	112	4	11.9	0.8
radish	654	4.7	0.1	73	4	8.2	0.6
rice, brown	10	0.46	0.07	62	4	7.7	0.3
rice, white	19	0.28	0.04	20	2	0.4	0.2
rice, wille	19	0.23	0.03	41 71	2	1. <del>0</del> 5.4	0.2
Shredded Wheat, breakfast careal	11-148	1.34	0.09	83	3	14.4	0.3
Shredded Wheat, breakfast cereal	11-148	0.9	0.1	90	5	16.1	0.6
soybean curd, tofu		14.4	0.2	50	2	8.4	0.6
soybeans, yellow		0.08	0.02	464	8	2.4	0.5
spinach, leaf raw		42.8	0.4	100	3	40.8	0.9
squash, butternut		0.06	0.03	119	4	11.8	0.4
squash, zucchini		0.01	0.01	90	3	14.8	0.4
squash, zucchini		0.03	0.02	56	2	9.4	0.4
sunilower seeds	666	0.09	0.02	104	5	7.9 11	0.6
tomato cherry	000	1.20	0.05	40 95	ง 1	4.5	0.2
willaw, ultilly	000	T'TT	0.0%	00	<b>T</b>	7.0	0.0

#### Table II (Continued)

		sodium		potassium		chlorine	
food	$code^b$	$\mu mol g^{-1}$	$\pm 1\sigma$	$\mu mol g^{-1}$	±10	$\mu mol g^{-1}$	±1σ
tomato, roma, home garden	666	0.47	0.04	68	2	10.0	0.2
wheat bran	11-5	0.8	0.1	390	20	13.3	0.9
wheat bran	11-5	1.5	0.2	450	20	16	1
wheat germ	11-34	1.5	0.3	260	20	25	4
wheat, whole		0.46	0.03	87	3	10.1	0.4
tea and water							
tea, Eng Breakfast		1.5	0.2	430	40	21	6
tea, green		1.9	0.2	380	20		
tea, leached Eng Breakfast		2.2	0.3	220	10		
tea, leached green		2.9	0.6	90	30		
tea, liq Eng Breakfast		0.21	0.02	4.3	0.7	0.40	0.05
tea, liq green tea		0.18	0.02	7.3	0. <b>9</b>	0.60	0.05
water, tap, Madison, WI		0.13	0.01			0.1	0.1
water, tap, Madison, WI		0.190	0.006			0.15	0.03
carbonated beverages							
7-Up, aluminum can		4.2	0.1			0.8	0.1
7-Up, plastic bottle		4.01	0.06			0.50	0.05
7-Up, plastic bottle		3.93	0.07				
Coca-Cola		1.45	0.03			15.9	0.8
Coca-Cola		1.06	0.2			16.2	0.8
Coca-Cola		1.43	0.03			4.05	0.09
Coca-Cola Classic		1.40	0.06			3.1	0.3

<sup>a</sup> The analytical uncertainties represent one standard deviation based on counting statistics. <sup>b</sup> The code number identifies foods compiled by Paul and Southgate (1978) and Holland et al. (1988).

of items per food sample was prepared for each analysis because the major objective of this study was to determine the interrelationships between sodium, potassium, and chlorine within foods and not the average composition of foods representative of the United States diet.

Samples of fresh produce were prepared for analysis by dissecting and removing cross-sectional samples from six or more items. A stainless-steel scalpel was used to cut the samples, but all other materials that contacted the foods were polyethylene. All containers and materials that contacted the samples were carefully washed with deionized water or reagent-grade methanol followed by deionized water. Approximately equal-sized subsamples were combined to produced a composite sample. A full bag of dried beans (456 g) and similar products were ground in a Wiley mill to pass a 0.425-mm (no. 40 mesh) screen prior to analysis.

Neutron Activation Analysis. In preparation for analysis, about 1.0 g of each composite sample was weighed and heat sealed into a 6.3-mm-i.d.  $\times$  6-cm-long polyethylene tube. Pure solutions of NaCl, KCl, and NBS bovine liver and orchard leaves were similarly packaged for standards and check samples, respectively. A piece of solid polyethylene rod, 6.3-mm diameter × 5-mm length, was placed in the bottom of the polyethylene tubes that received pulpy samples, such as meats, fruits, etc., so that the sample could be easily pushed out of the tube after neutron irradiation by ejecting the plug with a rod. The samples and standards were irradiated for 10 min in the University of Wisconsin Nuclear Reactor at a thermal neutron flux of  $9 \times 10^{12} \text{ n} \cdot \text{cm}^{-2} \text{ s}^{-1}$ . The samples were grouped to have similar sodium and chlorine concentrations to minimize variations in detector dead time. The samples and appropriate standards were irradiated in groups of 18 tubes. After irradiation, the samples and standards were transferred to 5-mL polyethylene vials for radioassay. Small amounts of water were used to ensure quantitative transfers when needed.

Each sample and standard was counted for 5 min using highresolution Ge(Li) detectors and a multichannel analyzer (Tracor Northern Model TN-11). The isotopes and their  $\gamma$ -ray emission lines (MeV) used analytically were: <sup>38</sup>Cl, 1.61 and 2.16; <sup>24</sup>Na, 2.75 and 1.37; and <sup>42</sup>K, 1.516. The results were calculated as given in Helmke (1982).

Statistical Analysis. Multiple linear regression was the primary tool of analysis using PROC REG SAS (SAS Institute, 1987). Regression analysis was done using data on all foods except commercial beverages (n = 156), and then by sorting foods into major food groups: fruits (n = 43); vegetables (n = 44); small grains (n = 29); legumes (n = 12); meat, fish, milk, and egg (n = 12); meat, fish, milk, mi

= 22); and nuts and mushrooms (n = 6). Separate analyses were performed with the dependent variable as concentration of chlorine and the independent variable as concentration of sodium, concentration of potassium, and concentration of sodium and potassium. A number of second-order regression equations were also examined. Each term in the regression models was assessed for significance, and adjusted  $r^2$  values were used to compare the amount of variation accounted for by the different regression models. In some cases, the second-order regression equations gave a larger adjusted  $r^2$  value than first-order regression equations; however, the biological significance of these relationships is unclear. Values obtained by neutron activation analysis for sodium, chlorine, and potassium concentrations in individual foods were also compared by regression analysis with values for similar foods in the British nutrient data base (Paul and Southgate, 1978; Holland et al., 1988).

## **RESULTS AND DISCUSSION**

The concentrations of sodium, potassium, and chlorine determined in NBS reference materials are given in Table I. The results generally agree within the reported analytical uncertainties. The results show that neutron activation analysis is very appropriate for the analysis of these elements in foods.

The concentrations of sodium, potassium, and chlorine in foods are given in Table II. The analytical uncertainty associated with each value represents one standard deviation analytical uncertainty based on counting statistics (Koons and Helmke, 1978) or 1%, whichever is greater. The codes identifying individual foods are those used in the British data base. Replicate analyses represent separate composite samples prepared from different suppliers or distributors.

The concentrations of chlorine and sodium in unsalted, unadulterated foods are weakly correlated ( $r^2 = 0.27$ , n = 156, P < 0.0001) when chlorine is regressed against sodium for all foods analyzed excluding commercial beverages. However, within individual food groups (Figure 1), only the food group that contained animal products (meat, milk, fish, and eggs) showed a significant correlation between chlorine and sodium concentrations,  $r^2 = 0.49$ , P < 0.001; the vegetable and legume food group showed a weak but significant correlation between chlorine and sodium concentrations,  $r^2 = 0.15$ , P < 0.01. Compared to other food



Figure 1. Concentration of chlorine as a function of sodium in four food groups. The equations for the only significant linear regressions are for meat, fish, milk, and eggs, Cl = 0.57Na + 6.97; and for vegetables and legumes, Cl = 0.40Na + 10.8.

groups that contained plant food sources, the animal products showed the greatest ranges of sodium (Na = 4-62  $\mu$ mol·g<sup>-1</sup>) and chlorine (Cl = 8-48  $\mu$ mol·g<sup>-1</sup>) concentrations. The correlation of chlorine and sodium in animal products is reasonable given the biological regulation of sodium and chlorine in extra- and intracellular fluids. Plants do not maintain similar strict regulation of sodium and chlorine in fluids, and the concentration of these ions may vary depending on soil and water conditions. However, even for animal products the correlation of chlorine with sodium concentration accounts for less than half of the variation, and thus, sodium concentration cannot be used to accurately predict the chloride content of individual unsalted foods.

The correlation between the concentrations of chlorine and potassium in foods was not significant (P = 0.90) when the regression model included all foods. Although, the food groups with higher potassium contents—fruits (K =  $4-108 \ \mu mol \cdot g^{-1}$ ), vegetables (K =  $8-172 \ \mu mol \cdot g^{-1}$ ), and legumes (K =  $234-509 \ \mu mol \cdot g^{-1}$ )—showed significant, although somewhat weak, associations between chlorine and potassium content,  $r^2 = 0.29-0.43$ , P = 0.01-0.001. The regression of chlorine versus potassium was not significant (P = 0.13-0.39) for animal products (K =  $11-104 \ \mu mol \cdot g^{-1}$ ) or small cereal grains (K =  $20-454 \ \mu mol \cdot g^{-1}$ ).

The value of  $r^2$  for chlorine concentration vs sodium plus potassium concentrations in all foods (Cl = a + bNa+ cK,  $r^2 = 0.26$ ) was similar to the value for regression of chlorine vs sodium for all foods ( $r^2 = 0.27$ , n = 156, P <0.001). The coefficient for the potassium term in the first case was not significant. This suggests that when a group of foods with a wide range of chlorine, sodium, and potassium concentrations are combined, the contribution of potassium, relative to the sodium concentration, contributes little to the prediction of chlorine concentration. For individual foods groups the same regression equation for chlorine concentration vs sodium plus potassium concentrations was significant for animal products ( $r^2 =$ (0.73), legumes ( $r^2 = 0.60$ ), fruits ( $r^2 = 0.34$ ), and vegetables  $(r^2 = 0.34)$ . Thus, for specific food groups inclusion of both sodium and potassium in the regression model improved the prediction of chlorine concentration. In summary, it is impossible to accurately predict chlorine concentrations in individual unsalted foods based on sodium or potassium concentrations given the large variation in the relationships between sodium, potassium, and chlorine concentrations in foods.

The generally good agreement between the values reported in the British nutrient data base (Paul and Southgate, 1978; Holland et al., 1988) for sodium ( $r^2 = 0.47$ , n = 110), potassium ( $r^2 = 0.79$ , n = 116), and chlorine ( $r^2 = 0.44$ , n = 86) and those obtained in this study demonstrate the applicability of neutron activation analysis for the determination of these elements in foods (Figure 2).

The slope of the line for the potassium concentrations shows the expected value of 1.00, which indicates excellent agreement. The poorer agreement for sodium (slope =(0.55) and chlorine (slope = (0.61)) is suspected to occur because the concentration of potassium  $(5-509 \,\mu \text{mol}\cdot\text{g}^{-1})$ is much higher in most foods than the concentrations of sodium  $(0.01-62 \,\mu \text{mol} \cdot \text{g}^{-1})$  and chlorine  $(0.04-48 \,\mu \text{mol} \cdot \text{g}^{-1})$ . Many of the values for sodium and chlorine reported by Paul and Southgate (1978) and Holland et al. (1988) were near the detection limits of the techniques employed and thus more susceptible to contamination and other errors. The slopes of the lines for sodium and chlorine in Figure 2 are much less than the expected value of 1.0 because several of the values reported by Paul and Southgate (1978) and Holland et al. (1988) are large compared to the values measured in this research. For example, the chlorine values for wheat bran of 42.3  $\mu$ mol·g<sup>-1</sup> (item 11-2 Holland et al., 1988) and for brown rice of  $64.9 \,\mu \text{mol} \cdot \text{g}^{-1}$  (item 11-35 Holland et al., 1988) were 4-8 times greater than the values determined in this study. The limit of detection of neutron activation analysis is much lower than those of most of the techniques used in the compiled data.

Knowledge of the sodium, potassium, and chlorine content of food may be useful for the correction of hypokalemic alkalosis, a common medical complication of diuretic therapy used for the treatment of hypertension. Potassium chloride (25-50 mmol of K·d<sup>-1</sup>) is often pre-



Figure 2. Concentrations of sodium, potassium, and chlorine as a function of the parallel values in compiled data bases (Paul and Southgate, 1978; Holland et al., 1988). The equations from the linear regressions are  $Na_{TR} = 0.55Na_{PS} + 1.45$ ;  $K_{TR} = 0.99K_{PS} - 1.21$ ;  $Cl_{TR} = 0.61Cl_{PS} + 4.64$ .

scribed for patients with diuretic-induced hypokalemia, although it is very unpalatable. Foods low in sodium content but relatively high in potassium and chlorine contents may be effective replacements for potassium chloride salts (Kassirer et al., 1965; Miller et al., 1979). The current data identify foods that contain relatively large amounts of potassium and chlorine and negligible amounts of sodium. A survey of the data in Table II indicates several foods meet these criteria. For example: 1 banana (120 g and 100 kcal) provides 0.03 mmol of Na, 11 mmol of K, and 3 mmol of Cl; 1 tomato (135 g and 25 kcal) provides 0.12 mmol of Na, 8 mmol of K, and 1.4 mmol of Cl; and Shredded Wheat cereal (50 g and 180 kcal) provides 0.06 mmol of Na, 4.6 mmol of K, and 0.75 mmol of Cl.

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