Nutritional Iodine in Processed Foods

Eugene J. Kuhajek
Howard W. Fiedelman
Morton Salt Company
Research Center
1275 Lake Avenue
Woodstock, Illinois 60098

ABSTRACT

This study evaluates the stability of various iodine compounds in processed foods. Samples of iodized salt (NaCl) containing potassium iodide, potassium iodate, or calcium iodate were used in experimental batches of bread, frankfurters, and potato chips prepared typically. No flavor or processing abnormalities were found. Iodine stability was generally acceptable for all iodine compounds, with at least 50–80% retention of iodine throughout processing and storage.

INTRODUCTION

Some iodine deficiencies persist in the United States despite the extremely small requirement of 140 micrograms per day for an adult male (Food and Nutrition Board, National Research Council, 1968) and despite the fact that adequate iodine has been available through the use of iodized table salt for almost 50 years. The White House Conference of Food, Nutrition, and Health (1969, p. 60) recommended that industry, government, and other agencies develop a program to encourage the public to use iodized salt.

The trend in U.S. food patterns has been toward increasing use of industrially processed and prepared foods, which are pre-salted with non-iodized salt. These foods are replacing food previously salted at home, often with iodized salt. Thus one apparent solution to possible iodine deficiency problems would be a selective iodization of processed foods.

EXPERIENCE WITH SALT ADDITIVES

Food processors, however, have been somewhat reluctant to deal with iodine fortification of foods for various reasons. Besides the normal problems of quality control involved in adding precise amounts of an iodine-containing substance, there also undoubtedly are fears of adverse effects upon food processing, appearance, flavor, and odor. Although Joslyn and Timmons (1967, p. 95) commented that iodized salt should not be used in food processing, we have been unable to document their claim of adverse effects on color and flavor of food products. Kojima and Brown (1955) found no undesirable effects from the use of iodized salt in canned tomato juice, bulk or canned sauerkraut, canned green beans, canned whole kernel yellow corn, or bottled pickled olives.

According to F. C. Lamb (1972, personal communication) of the National Canners Association, the canning industry had opposed the use of iodized salt because of an observed interaction with tinplate. However, El Wakeil (1958) established that this reaction was due to the presence of sodium thiosulfate, which is no longer used to stabilize potassium iodide in iodized salt.

This article presents an evaluation of the effects of iodine from various sources upon food processing including the determination of iodine stability during food preparation and storage.

PREPARATION AND ANALYSIS OF SALT SAMPLES

Preparation

Batches of iodized salt were prepared with potassium iodide, potassium iodate, and calcium iodate as sources of iodine. Dendritic salt (NaCl) was selected for several reasons, mainly its non-caking characteristics and its ability to adhere to potato chips. Both potassium iodide and potassium iodate were added to the salt as a water solution. Since potassium iodide in salt is subject to oxidation, it was stabilized as is normal for iodized salt, by mixing with 4 grams of dextrose and 0.55 grams of sodium bicarbonate per gram of potassium iodide. Because of the limited water solubility of calcium iodate, it was incorporated into the salt as a solid, with 0.1% propylene glycol added to prevent segregation.

The elemental iodine level in each iodized salt, as shown in Table I, was 0.0077%, equivalent to the normal 0.01% potassium iodide level in iodized table salt. After preparation, each salt sample was analyzed to verify the iodine content; each was reanalyzed at the time of usage in a food.

Analysis of iodine in foods

Iodine analyses were performed on finished food products by Shuman Chemical Laboratory, Battle Ground, Indiana. The analytical procedure involves combustion of the food in an oxygen stream, with absorption of the products in a sulfuric acid-chromic oxide mixture. Addition of water to the acid mixture, followed by boiling, oxidizes all iodine to iodate. Phosphorous acid, arsenious acid, and hydrogen peroxide reduce the iodate, and the iodine and the hydroiodic acid are distilled into an alkaline solution. Iodine content of the distillate is measured by its catalytic effect upon reduction of ceric sulfate by arsenious acid.

FOOD PRODUCTS TESTED

Bread, potato chips, and frankfurters were prepared with the various iodine compounds, and analyzed before and after storage.

Bread

Loaves of white bread containing 2% of each of the provided salt samples were baked by the American Institute of Baking, Chicago, Illinois. They were prepared in the normal manner and observed for possible abnormalities in fermentation, appearance, aroma, and taste.

No difference was observed in fermentation time, proof time, internal appearance, taste, or aroma among control and iodized bread samples. Iodine stability was checked 2 days after preparation of the bread and then after 10 days in freezer storage. As shown in Table II, iodine retention is surprisingly good—at least 70% retention throughout baking, freezer storage, and air-drying (in preparation for iodine analysis).

TABLE I

Analysis of Iodized Salt Samples

Source of Iodine	Additive Level in Salt (%)	Iodine Level in Salt (%)
Potassium iodide[a]	0.0100	0.0077
Potassium iodate	0.0128	0.0077
Calcium iodate	0.0118	0.0077

[a]Stabilized with dextrose and sodium bicarbonate.

TABLE II

Iodine Stability in White Bread[a]

Iodine Additive	Iodine Concentration[b] (ppm)		Iodine Retention[c] (%)	
	2 days after preparation	After 10 days in freezer	2 days after preparation	After 10 days in freezer
Potassium iodide	1.14	1.09	76	73
Potassium iodate	1.24	1.07	80	70
Calcium iodate	1.10	1.11	73	74

[a]All values adjusted to 2.00% salt content for easier comparison.

[b]Corrected for iodine content of control (0.38 ppm).

[c]Based only on iodine added with salt.

Potato chips

Potato chips were produced by the Frito-Lay Research Department, Irving, Texas, using the salt samples added at the normal 2% level. The prepared chips were stored in an unheated room in multiple plastic bags protected from light.

The samples of potato chips were analyzed for iodine content after 7 weeks and 13 weeks of storage. The results are shown in Table III. Since salt content varied somewhat, all iodine values in the table have been adjusted to 2% salt for easier comparison of results. The low value for potassium iodate at 13 weeks probably represents analytical difficulties. Taste panel tests 4 weeks after preparation of the chips showed no significant flavor differences between iodized and un-iodized chips.

Frankfurters

Four lots of frankfurters, both iodized and un-iodized, were made by the Swift Research & Development Center, Oak Brook, Illinois, in a manner typical for the industry. During preparation of the emulsion, the meat batter was observed carefully for any atypical change; none was noted. The frankfurters were stuffed into cellulose casings, smoked using natural smoke, chilled overnight, then

TABLE III

Iodine Stability in Potato Chips[a]

Iodine Additive	Iodine Concentration[b] (ppm)		Iodine Retention[c] (%)	
	7 weeks	13 weeks	7 weeks	13 weeks
Potassium iodide	1.14	0.94	82	67
Potassium iodate	1.22	0.71	81	48[d]
Calcium iodate	1.19	1.12	77	73

[a]All values adjusted to 2.00% salt content for easier comparison.

[b]Corrected for iodine content of the control (0.28 ppm).

[c]Based only on iodine added with salt.

[d]Value out of line, apparently due to analytical difficulty.

TABLE IV

Iodine Stability in Frankfurters

Iodine Additive	Iodine Retention[a], (%) Frozen[b]	Refrigerated[c]	Prepared[d]
Potassium iodide	46	61	93[e]
Potassium iodate	54	53	65
Calcium iodate	41	60	52

[a]Based only upon iodine added with salt.

[b]Frozen for 18 weeks.

[c]Frozen for 20 weeks, then placed in sandwich bags and refrigerated at 42°F for 10 days.

[d]Frozen for 22 weeks, then thawed at room temperature and prepared by simmering in hot water for 5 minutes.

[e]Value out of line, apparently due to analytical difficulty.

peeled. Samples from each lot were inspected and found to be typical in texture and cure-color development. The same was true after heating in simmering water for 5 minutes. As for flavor, the frankfurters containing calcium iodate were described by one or two tasters as atypical, slightly bitter or astringent. Even this batch, however, received a good flavor rating. It may be that relatively insoluble iodine sources, such as calcium iodate, are undesirable because they are not sufficiently distributed throughout certain food products.

The remaining frankfurters were packed in polyethylene bags and frozen, then kept in freezer storage for 20 weeks. Iodine content was checked after the prolonged freezer storage, then after refrigerator storage for 10 days, and again after preparation in hot water. The results are shown in Table IV. Again, one iodine value, that for potassium iodide in prepared frankfurters, is clearly out-of-line and undoubtedly results from analytical difficulties.

CONCLUSIONS

No flavor or processing abnormalities were found in this study, and iodine stability was generally acceptable for all iodine compounds, with at least 50–80% retention of iodine throughout processing and storage. Of the compounds tested, only potassium iodide (which is used for iodizing table salt) has Food and Drug Administration approval as a source of dietary iodine. This study therefore indicates that:

1) Iodization of processed foods is feasible.

2) Salt is an acceptable carrier for the iodizing additive.

3) Potassium iodide is a practical and reasonably stable iodine source.

Although the desirability of iodine fortification of commercial foods is a separate and complex nutritional problem, this study shows that such fortification is feasible.

REFERENCES

El Wakeil, F. A., 1958. Effects of iodized salt and other iodine compounds on the quality of processed vegetables. *Ph.D. thesis.* Columbus, The Ohio State University, 256 pp.

Food and Nutrition Board, National Research Council, 1968. *Recommended dietary allowances.* National Academy of Sciences Publication 1694, Washington, D.C.

Joslyn, M. A. and Timmons, A. 1967. Salt–use in food processing. In, Heid, J. L., and Joslyn, M. A., (Editors), *Fundamentals of food processing operations.* Westport, Conn., Avi Publ. Co., 730 pp.

Kojima, N. and Brown, H. D., 1955. The effects of iodized salt in processed fruits and vegetables. *Food Technol.* 9:103–107.

White House Conference on Food, Nutrition, and Health, 1969. Final report. Washington, D.C., U.S. Govt. Printing Office, 341 pp.