Human consumption of iodine has increased to amounts which are about equal to the upper safe level as set by the National Research Council. One of the major sources for the greater iodine consumption is an increase in the amount reported in milk and other dairy products. The mammary gland does not limit the amount of iodine secreted in milk as it does with many other elements. Increased use of organic iodine in feed has resulted in high levels in milk in some dairy herds. Most of the herds with levels above 1,000 μg/liter were fed organic iodine above recommended levels as a prevention for foot rot. Iodine teat dips and udder washes can contribute additional iodine to the milk. In a few instances, the misuse of iodine sanitizers in the dairy industry has also contributed to increased milk iodine. If milk iodine levels are to be held at the present level or decreased, iodine feed supplementation and sanitizers must be used as currently recommended.

Interest in iodine consumption by humans has switched from a need to increase average intake to prevent goiter and other deficiency symptoms to a concern that iodine intake may be too high for some individuals (28, 29). An estimate for average dietary iodine consumption for adult males was 150 μg per day for 1960 but increased to 454 μg for 1970 (28). More recent estimates, based on determination of the content of typical diets for infants, toddlers and adults in various regions throughout the United States, indicate a further increase in the average iodine consumption. Vanderveen (33) reported average iodine intakes of 1132 μg for 1974, 750 μg for 1975, and 952 μg for 1978 for adult surveys. Results for infants and toddlers were of the same magnitude.

The Food and Nutrition Board of the National Research Council (4) currently recommends iodine intakes between 100 and 300 μg/day to meet the needs of most healthy adults. Intakes for adults between 50 and 1000 μg/day are considered safe. Recommendations for infants are somewhat lower. The surveys of Vanderveen (33) demonstrated average intakes of 4 to 13 times the recommended levels and some exceed the upper safe level. The "safe level," as set by the National Research Council, probably contains a fairly large safety factor, and intakes above the "safe level" should not necessarily be considered toxic. Vanderveen (33) estimates that dairy products were the major contributor, accounting for 56 to 85% of the iodine in adult diets. In addition, use of milk in other foods such as bread could increase the amount contributed by dairy products to the total consumed.

MILK IODINE VALUES

Published values for milk iodine content before 1970 were generally below 100 μg/liter although a few higher values up to 165 μg were reported (10). The low milk iodine content of many of these samples would not enable milk to supply enough iodine to meet the daily requirements of many individuals. The data demonstrated a large difference between goitrous and nongoitrous areas, with 96% of the reported values below 50 μg/liter in goitrous areas as compared with 62% in nongoitrous areas.

Since 1970, most of the milk iodine values reported (6, 10, 15, 18) are higher than those noted earlier. Most of the increase is probably an actual increase; however, some of the higher values may be due to improved analytical techniques. The analytical errors involved before 1970 were more likely to result in underestimating rather than overestimating iodine content.

Based on a farm survey in Tasmania (Australia), Connally (6) reported values of 113 to 346 μg/liter where sanitizing agents containing iodine had been used. Hemken et al. (15) reported in 1972 a survey of farms from Illinois and Maryland. The 12 Illinois farms averaged 425 μg/liter and the Maryland farms averaged 457 μg/liter with a range in values from 63 to 1610 μg/liter. Dunsmore (9), in a survey of Australian milk at various stages in the market chain, reported average values of 570 μg/liter (range of 370 to 1070) for factory raw milk samples and an average value of 706 μg/liter (range of 320 to 1120) for bottled pasteurized milk. A survey of milk purchased from stores in Lexington, Kentucky in 1976 gave an average value of 317 μg/liter. Very high values were reported in Michigan.
with the amount consumed at somewhat normal secreted. The iodine content of milk is highly correlated
straight-line relationship at very high levels of intake as
foot rot is not clearly documented.

iodide (EDDI). California (2), Michigan (8), Wisconsin
sanitizers used in various steps of milk production and
areas as either goitrogenic or nongoitrogenic. In turn,
no clinical effect was observed in cows fed 150 mg of iodine
supporting this concept. Another study observed that
study of Mikesell et al. (13) did not support the possibility
a transfer of high levels of EDDI from feed to milk is

(8) when herds fed 164 mg of iodine (2200 μg/liter of
milk) were compared with herds fed an average of 16 mg
of iodine (370 μg/liter of milk).

A report from California (3) demonstrated that dairy
products other than whole milk also contain ample
quantities of iodine. While farm milk samples in
California had an average content of 357 μg/kg (range of
58 to 4520 μg/kg), dairy products contained an amount
of iodine which would reflect the content of raw milk. For
example, the average iodine content of sour cream was
284 μg/kg, of ice cream 387 μg/kg, and of buttermilk
370 μg/kg.

High residues of iodine were found in cheese which
was classified as off-flavor (Hicks, unpublished data).
The off-flavor resulted when mozzarella cheese was
manufactured from non-fat dry milk that contained a
relatively high level of iodine.

These surveys implicate several sources of iodine.
Dietary iodine from various sources, together with iodine
sanitizers used in various steps of milk production and
milk processing, have been shown to end up in the final
dairy product. The relative contribution of each source
must be known if we desire to limit the amount of iodine
in dairy products.

**FEED SOURCES OF IODINE**

The iodine content of plants will reflect the content of
soils. This well-established fact is the basis of labeling
areas as either goitrogenic or nongoitrogenic. In turn,
milk iodine will reflect the feeds consumed, and the milk
content has been used as a method of determining the
adequacy of rations (1). Milk values below 25 μg/liter
indicate the cow is probably not receiving her required
iodine. Feed sources other than products such as kelp
(17) would not be expected to result in iodine values
above 100 to 150 μg/liter.

Supplemental iodine is added to dairy cow rations for
several reasons. Some is added to most rations to meet
the dietary requirements and prevent iodine deficiency.
In addition, organic iodine is sometimes added to
prevent foot rot, and some dairymen use it in an attempt
to improve reproductive efficiency (22,24) and correct
other problems. The efficacy of high levels of organic
iodine above iodine requirements to improve reproductive
performance and prevent health problems other than
foot rot is not clearly documented.

While the mammary gland is efficient in limiting the
amount of elements such as iron, copper, cadmium and
some others (31), it does not limit the amount of iodine
secreted. The iodine content of milk is highly correlated
with the amount consumed at somewhat normal amounts of intake. Milk content is apparently not a
straight-line relationship at very high levels of intake as
the amount entering milk is reduced when calculated as
a percentage of the amount consumed.

Some of the recently reported high milk iodine values
have been related to feeding of ethylenediaminedihydro-
iodide (EDDI). California (2), Michigan (8), Wisconsin
(26) and Kentucky (17) surveys of milk iodine content
have related most of the milk values reported which
exceeded 1000 μg/liter to feeding of organic iodine. The
transfer of high levels of EDDI from feed to milk is
supported by controlled studies (13,23). The study of
Miler and Swanson (23) included one group of cows which received iodine in the form of potassium iodide
(KI). The group receiving EDDI had lower serum and
higher milk iodine values than the group receiving KI.
This demonstrates a different metabolism for these two
forms of iodine, and indicates the EDDI increases milk
iodine over the amount from an inorganic source.

**TEAT DIPS**

A number of studies have demonstrated that iodine
teat dips do increase the iodine content of milk
(6,7,12,18,19,20,27,30,32). The absence of good controls,
the wide range of management conditions on the farm
and the large variation of teat dip formulation have
probably contributed to the confusion in the interpretation
of published results.

The iodine content of teat dips studied has varied from
0.1 to 1.6%. While 1% iodine teat dips are the most
commonly used formulation in the United States, much
of the world literature is based on lower levels of iodine in
the formulation. Iwarrson and Ekman (18) reported an
average increase of 174 μg/liter, with a range of 55 to
353 μg, when a teat dip containing 16 g (1.6%) of iodine
per liter of dip was tested. Additional studies (18) by this same
group with formulations containing 8 g (0.8%) of iodine
per liter of dip demonstrated a reduction of 50 to 60% in
the amount of iodine contributed by the teat dip. Terplan
et al. (30) made a direct comparison of teat dips
containing 0.75, 0.6, and 0.5% iodine, and obtained milk
iodine values of 130, 85, and 77 μg/liter, respectively,
Dunsmore et al. (12) and Sheldrake et al. (27) compared
formulations containing 0.1 and 0.5% iodine, and both
studies show a large reduction in milk iodine with the
lower level in the teat dip. While these direct
comparisons are clearly indicative of reduction in milk
with reduction in the concentration of iodine in the teat
dip, comparative studies with the same concentration
between stations show a wide range in milk iodine values.

The formulation of ingredients other than iodine in the
teat dip is another factor which can influence addition of
iodine to milk. Dunsmore et al. (12) stated that the most
suitable dips were relatively nonviscous and did not
contain polyvinyl pyrolidone or carboxymethylcellulose
as thickening agents. Lewis et al. (21) have compared
three teat dips with differing viscosity, all three contain­
ing 1% iodine. Milk iodine levels were increased above
control; 84.9 μg/liter for the most viscous, 53.6 μg/liter
for the intermediate treatment and 37.0 μg/liter for the
least viscous product. Additional studies need to be
conducted in this area to compare the various
formulations being marketed.

Premilking treatment of cows to remove residues
remaining on the teats is very important with some teat
dips. Sheldrake et al. (27), using teat dips containing
either 1,000 or 5,000 mg (.1 and .5%)/liter, reported
iodine levels of 70 and 99 µg of iodine per quarter per milking with thorough washing and drying of teats and 143 and 291 µg of iodine per quarter per milking, respectively, for no premilking udder preparation. Dunsmore et al. (11), while stating that premilking udder preparation is important, did not demonstrate a marked reduction due to preparation other than by comparison of one experiment with another. Using a teat dip containing 0.5% iodine and thorough prewash treatment, they found milk iodine to be 57 µg/liter higher than that of undipped control cows. They did demonstrate that premilking treatment to remove iodine was more effective in reducing milk iodine when a viscous rather than non-viscous teat dip had been used.

Other factors such as milk production level, percentage of the teat dipped, the weather and the efficiency of the dairyman in washing, wiping and dipping the teats have been suggested as factors which can influence the amount of iodine residue.

When levels of iodine of 0.5% or higher are used, thorough washing does not reduce the iodine to undetectable levels. Conrad and Hemken (7) have demonstrated that a major portion of the iodine found in milk when cows are thoroughly washed before milking is due to absorption of the iodine and later resorption into the milk. Sheldrake et al. (27) reported that absorption and resorption accounted for only 36% of the residue in an experiment where a 0.5% iodine teat dip had been tested.

A recent study by Lewis et al. (21) demonstrates that a 1% iodine teat dip can increase blood serum iodine levels. This is further proof that absorption occurs and milk levels would be expected to increase if serum levels were increased. The formulation of other components could influence the relative amount of iodine absorbed, as well as influenced the amount of residue remaining on the teat at milking time.

**PREMILKING UDDER WASH**

Iodophors are used as a premilking sanitizer in washing the udder in some herds. They are also used as sanitizers on some farms for rinsing pipelines or rinsing teat cups between milking individual cows. Depending on the iodine content of the solutions and the amount of residue which gets mixed with milk, this may be another source of increased milk iodine content.

While Cantor and Most (5) could not detect a significant increase in milk iodine when using an iodine premilking udder wash, both Dunsmore and Nuzum (11) and Hemken et al. (16) reported measurable increases. Both studies reported increases of about 35 µg/liter, which is below the increased amount reported when teat dips containing 0.5% iodine or higher were used. However, misuse of premilking washes could conceivably add considerably more iodine. Some (25) have questioned the effectiveness of sanitizers to effectively reduce bacterial numbers. Their effectiveness as a premilking udder wash should be proven to either reduce the incidence of mastitis or reduce the bacterial content of milk if their use is to be recommended.

**OTHER SOURCES**

Currently there is an interest in flushing milking equipment between individual cows with iodine sanitizers to reduce the incidence of mastitis. Bruhn et al. (4) have checked the amount of iodine added by milking machines and suggest that proper management can reduce the iodine concentrations due to machines to 50 µg/liter (11). Another study (7) has demonstrated that tincture of iodine placed on other parts of the cow will increase iodine in both blood serum and milk. It seems unlikely that this source would add measurable amounts to herd levels of iodine; however, those individuals treated would reflect this treatment.

While iodine sanitizers are not used as extensively in the processing of milk as are other sanitizers, their misuse in this phase of the industry could add additional iodine to dairy products. In Australia, Dunsmore (9) has reported some increase in iodine content of dairy products because of iodine sanitizers used in the manufacturing process; however, the major portion of iodine in dairy products was due to the iodine content of raw milk.

While there does not seem to be any human health problem associated with the current levels of iodine consumption, there seems to be little justification to continue the past trends for increasing milk iodine. Herds which are fed EDDI should receive the product as recommended by the manufacturer. Iodine teat dips and udder washes, if used as recommended, do not contribute more than 100 to 150 µg/liter. Teat dips with levels of iodine under 1% should be used if the efficacy to reduce new mastitis infections is clearly established. Any change in the use of iodine as either a feed ingredient or as a sanitizer should be monitored as to its effect on the milk content. Based on current knowledge, the industry should try to decrease or prevent further increases in milk iodine levels.

**REFERENCES**


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