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Dry Heated Cow's Milk Protein and it's Immunogenicity

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Abstract

The use of whole cow's milk in infant feeding has decreased in recent years (1). Nonetheless, many parents continue to transition their infants from breast milk or formula to whole cow's milk when they are less than a year old. Whole cow's milk should not be consumed before the age of one year in the United States (2) and the United Kingdom (3). Whole cow's milk can be introduced gradually from nine months of age in Denmark (4) and from ten months of age in Sweden (5). The Nutrition Committee of the Canadian Pediatric Society recommends that whole cow's milk be introduced between the ages of nine and twelve age of months (6). There are risks associated with the early introduction of whole cow's milk.

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Introduction

Cow's milk protein allergy (CMPA) is one of the most commonly reported food allergies in infants and young children, accounting for 10% of all adverse food reactions. (1) CMPA manifests itself within the first two months of life and has been reported to affect 1% of children under the age of two in Europe. (2) CMPA is outgrown by the age of three in 50% of IgE-mediated CMP allergic children. (2, 3) The most effective therapy is strict allergen avoidance. However, this treatment has significant limitations in terms of live quality and necessitates the use of other sources to ensure the infant's optimal nutritional sustenance. (4) Previous research has found it was discovered that 75% of CMP allergic children could tolerate "baked milk." Furthermore, over a 5-year follow-up period, 60% of the baked milk tolerant patients were able to develop tolerance to raw milk. (5, 6) Baked milk is a term for CMP that has been baked into a food matrix (e.g. muffins, waffles, and

pizza cheese). Prior studies, however, used an undefined CMP and matrix. Furthermore, little is known about the physical and chemical changes that occur in CMP during extensive dry heat treatment, and how this correlates with the protein's immunogenicity. Our Main Aim are

- Identifying physical and chemical changes in extensively dry heated CMP
- Examining the relationship between these changes and protein digestion in a model system of infant digestion
- Describe the physical/chemical changes as well as the digestion products.

CMP immunogenicity is influenced by the dry heated CMP, respectively.

Approach

The physical and chemical changes in heated CMP after extensive dry heating are investigated. This refers to the degree of denaturation/aggregation, the formation of advanced glycation end products (AGEs), and the type of protein cross-linking. UHPLC-MS/MS is used to monitor AGEs and protein cross-linking(7,8), while denaturation/aggregation is investigated using a combination of methods including SDS-gel electrophoresis(9), OPA-method, Elman-method, Thoi Flavian-T-assay(10), and electron microscopic methods8. The effect of dry heated CMP on enzymatic proteolysis is critical and will be taken into account when studying the immunogenicity of heated products in vitro.

IRON DEFICIENCY ANEMIA

The consumption of whole cow's milk has been linked to occult blood loss from the gastrointestinal tract in both early and late infancy. At 168 days of age, Ziegler et al (7) randomly assigned 52 infants to receive either whole cow's milk or a milk-based formula. The proportion of guaiac-positive stools increased from 3 percent at baseline to 30.3 percent during the first 28 days of the trial (P0.01), whereas the proportion of guaiac-positive stools remained low (5 percent) with formula feeding. Although the proportion of guaiac-positive stools in infants fed whole cow's milk decreased over time, it remained significantly higher (P0.01) across the board. Stool hemoglobin concentration increased significantly with the addition of whole cow's milk, rising from a mean

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(SD) of 622 527 g/g dry stool at baseline to 359810,479 g/g dry stool during the first 28 days of ingestion. Stool hemoglobin in formula-fed infants did not increase and was significantly (P0.01) lower than in whole cow's milk-fed infants. Although all normal infants lose measurable amounts of blood in their faces, feeding whole cow's milk causes increased enteric blood loss in a large proportion of normal infants (7, 8). It has been proposed that feeding a heat processed cow's milk proprietary formula would not result in increased enteric blood loss that a heat labile protein found in whole cow's milk, such as bovine albumin, is to blame for intestinal bleeding (8). Cow's milk-induced blood loss typically occurs only during childhood; even extremely sensitive infants can tolerate whole cow's milk later in life without adverse effects (8).

Iron levels in breast milk and whole cow's milk are both low, ranging from less than 0.3mg/L to 1 mg/L. (9). Iron in breast milk is highly bioavailable, possibly due to the lower calcium and phosphorus levels the presence of lacto ferric and the presence of phosphorus (9). Bovine milk proteins, on the other hand, are strong inhibitors of iron absorption. Approximately 50% of the iron in breast milk is absorbed, whereas only 10% of the iron in whole cow's milk is absorbed (10).

Several studies found that feeding infants whole cow's milk instead of iron-fortified formula at six months of age resulted in an increase in iron deficiency by one year of age (11,12). Supplemental foods may not always provide adequate iron levels in the second six months of life (2, 11). Iron deficiency anemia, particularly during the first two years of life, can have a negative impact on behaviour and psychomotor development (13).

NUTRITIONAL CONSIDERATIONS

Protein accounts for approximately 7% of the calories in human milk and 20% of the calories in whole cow's milk (14). Although the amounts of whey protein are comparable, whole cow's milk contains six to seven times the amount of casein that human milk does (14). Human milk has whey to casein ratio of approximately 35:65, whereas whole cow's milk has whey to casein ratio of 19:81. (14). Whole cow's milk has high casein content, which is undesirable because casein forms a tough, difficult-to-digest curd that is difficult for young infants to digest (15). Amino acids are

chemical compounds Human milk contains much higher concentrations of turbine and cysteine than whole cow's milk (13). These amino acids may be necessary for premature babies.

Lipids account for half of the calories in both human and whole cow's milk. Human milk contains more linoleic acid and polyunsaturated fatty acids than whole cow's milk. Linoleic acid accounts for 4% of calories in human milk but only 1.8 percent in whole cow's milk, with a recommended level of 3%. (2). the fatty acid profile of infant formulas closely resembles that of human milk. As a result, fats in infant formulas are well absorbed by the majority of infants compared to those found in whole cow's milk (14).

Whole cow's milk is also low in zinc, niacin, vitamin C, and vitamin E. (6). Whole cow's milk contains roughly three times the amount of sodium and potassium, four times the amount of calcium, and six times the amount of phosphorus as human milk (14). The high phosphate load has been implicated as a cause of neonatal late hypocalcemic tetany (14). For all of the reasons stated above, it is best to wait until the infant is one year old before introducing whole cow's milk.

HIGH RENAL SOLUTE LOAD

The use of whole cow's milk increases the renal solute load by increasing protein, sodium, potassium, chloride, and phosphorus intake (6, 16). Whole cow's milk has a higher renal solute load, resulting in urinary osmolality that is roughly twice that of breastfed infants (17). While there is no evidence to suggest that increased renal solute load causes adverse clinical squeal in healthy infants, feeding whole cow's milk would reduce the margin of safety in situations that could lead to dehydration (16). Whole cow's milk may not provide enough free water in situations where water intake is reduced (eg, vomiting) or water loss is increased (eg, diarrhea, hot environment). Dehydration may occur if no additional water is provided.

COW'S MILK ALLERGY

Cow's milk allergy affects between 0.3 and 7.5 percent of infants (18). There is no evidence that whole cow's milk is more allergenic than infant formulas with intact cow's milk proteins. Infants

who are allergic to cow's milk protein should not be fed whole cow's milk or formulas containing intact whole cow's milk proteins (2).

Early exposure to cow's milk proteins increases the likelihood of developing a milk protein allergy. The intestinal epithelium becomes less permeable to macromolecules as it matures There is also a lower risk of allergic reactions. The introduction of whole cow's milk should be based on nutritional considerations rather than the development of a mucosal barrier to cow's milk proteins in normal infants with no known history of allergy to cow's milk (2).

Several studies have discovered cow's milk antigen in human milk (19, 20). Even minor amounts of cow's milk protein in human milk can cause allergic reactions (21). Several researchers discovered that the incidence of atopic dermatitis was significantly lower in children whose lactating mothers ate a diet free of cow's milk whereas the incidences of all other atopic manifestations were comparable to a control group of children whose mothers did not have any dietary restrictions (22, 23). Other researchers discovered no difference in the development of atopic diseases in children whose mothers avoided cow's milk in their diet (24). At this time, it is premature to advise atopy families to avoid whole cow's milk during lactation. More research is required before a firm recommendation can be made. However, if a lactating mother notices that whole cow's milk consumption appears to cause an allergic reaction in her infant, it is reasonable to eliminate whole cow's milk from her diet.

DIABETES MELLITUS

Many (25–28) but not all (29) studies have found a link between early exposure to cow's milk proteins and an increased risk of type 1 diabetes mellitus. Some children develop insulin antibodies after being exposed to cow's milk proteins (25, 26, and 28). In genetically susceptible individuals, bovine serum albumin may elicit an immune response, which then cross-reacts with a beta-cell surface protein, p 69. (25, 26) This protein's expression on the surface of beta cells is thought to mediate their destruction by exposing them to immune attack (26). Diabetes mellitus may develop as a result of beta cell destruction. According to the American Academy of Pediatrics, in families with a strong history of insulin-dependent diabetes, during the first year of life, it is strongly

advised to avoid commercially available cow's milk and products containing intact cow's milk proteins, as well as breast-feeding (30). Commercial infant formulas containing cow's milk protein are an acceptable alternative because the antigenicity of infant formulas and whole cow's milk may differ, and there is no evidence against using formulas for infants whose mothers do not breast-feed (30). These recommendations should be followed until the relationship between cow's milk proteins and diabetes mellitus is determined by prospective well-designed randomised trials.

CONCLUSION

Human breast milk is the best food for infants. If human milk is unavailable, iron-fortified formulas, rather than whole cow's milk, should be used during the first year of life.

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