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An Assessment of the Effects of Pasteurisation on Claimed Nutrition and Health Benefits of Raw Milk

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1 Background

There is currently considerable debate on the potential health benefits from the consumption of raw cow's milk compared to pasteurised milk. Pasteurisation is believed by some to destroy or damage components that could be beneficial to consumers. Raw milk is thus perceived to be a better source of nutrients and other active components that provide health benefits than pasteurised milk. There is also a belief that some conditions e.g. lactose intolerance, are manifested in consumers of pasteurised milk but that the intolerance does not occur with raw milk. Another important area of debate is possible linkages between raw milk consumption and the development of the immune system, especially in relation to allergic conditions in children.

Pasteurisation of milk is a heat treatment intended to:

- reduce the number of any harmful microorganisms, to a level at which they do not constitute a significant health hazard;
- reduce the level of undesirable enzymes and spoilage bacteria, and thus increase the keeping quality;
- achieve the preceding two goals while maintaining the nutritional integrity of the original product.

Commercial pasteurisation methods in New Zealand include the following treatments:

a) rapidly heating milk to a temperature of no less than 72° C and retaining it at that temperature for no less than 15 seconds; or
b) rapidly heating milk to a temperature of no less than 63° C and retaining it at that temperature for no less than 30 minutes.

Pasteurisation can be achieved in a variety of ways; from a pot on the stove in the kitchen at home to a vat or silo in a commercial enterprise, or by running the milk through a series of temperature controlled pipes and equipment as occurs in many dairy factories. Pasteurisation of milk assures safety for human consumption by reducing the number of live pathogenic (harmful) bacteria present. The public health benefits of pasteurisation are well established and are not the focus of this paper. Despite the risk of foodborne illness associated with consuming raw milk, raw milk is considered by some to have more health benefits than pasteurised milk, for example, better nutritional value and disease prevention. Whereas milk quality and safety have been the topics of many research studies, raw milk benefits continue to be a issue for debate. (Claeys *et al.*, 2012; and MacDonald *et al.*, 2011).

2 Aim

The main objective of this report is to evaluate the nutritional and health benefits that are claimed to be associated with the consumption of raw milk and the potential detrimental effects of pasteurisation. This review includes discussion and analysis of scientifically derived data regarding raw milk benefits and potentially negative effects of pasteurisation.

3 Methods

To achieve this aim the following research steps have been undertaken:

- Based on a literature search and screening of the relevant websites, major benefits that are claimed to be specific to raw (unpasteurised) milk have been identified.
- Evidence related to each of the perceived raw milk benefits, has been searched for in the peer reviewed scientific literature, published reports of international regulatory authorities and the World Health Organisation.
- Based on data presented in the scientific literature, the potential impact of pasteurisation on the health benefits of raw milk has been evaluated.

4 Claim 1 "Raw milk has a higher nutritional value than pasteurised milk"

The nutritional value of food depends on the nutrient content (proteins, fat, carbohydrates, vitamins and minerals), in addition to the absorption and utilisation of these nutrients in the body. The nutritional value of a food it is often considered in relation to how much of the nutrients in a single serve of the food contributes to the Recommended Dietary Intake (RDI).

There are two aspects to this claim. The first is that pasteurisation significantly decreases the amount of available nutrients and the second is that this decrease negatively impacts an individual's nutrient intake Food composition data can be used to evaluate the differences in the nutritional value of raw versus pasteurised milk. Nutrition surveys can provide information about important dietary sources and their contribution to the intake of the nutrients. However, the nutrition surveys that have been undertaken to-date predominantly investigate the consumption of pasteurised milk. Thus, an evaluation of the influence of heat-treatment on nutritional value of milk should consider what effect the consumption of raw milk compared to pasteurised milk has on an individual's nutrient intake in the context of the total diet. The same changes in a particular nutrient may have different impact depending on importance of milk as a source of the nutrient. Information on the dietary intakes and food consumption patterns of New Zealanders is available at: http://www.health.govt.nz/publication/2008-09-new-zealand-adult-nutrition-survey-data-tables).

Nutrient reference values, including the RDI of specific nutrients for New Zealanders, are reported in the in "National Health and Medical Research Council (NHMRC) Nutrient Reference Values for Australia and New Zealand: Including Recommended Dietary Intakes" : http://www.health.govt.nz/publication/nutrient-reference-values-australia-and-new-zealand

4.1 PROTEINS AND AMINO ACIDS

The two major groups of milk protein are casein (80% of the milk protein) and whey protein (about 20%). Pasteurisation has little impact on casein structure and cause minor changes to whey protein structure (Braun-Fahrlaender and von Mutius, 2011, Claeys *et al.* 2012).

Casein molecules are precursors of several bioactive peptides, which are inactive in the native protein, but have a physiological effect in the body after digestion (Claeys *et al.* 2012). Animal studies showed no difference in protein efficiency ratio and protein digestibility between raw and pasteurised bovine milk (Efigenia *et al.*, 1997; Lacroix *et al.*, 2006). In a human study, Lacroix *et al.* (2008) observed the same metabolic utilisation of milk protein for both raw and pasteurised milk.

Only small losses (1-4%) of the available amount of essential amino acids, including lysine, were observed after heating (pasteurisation), and the effect appears to be negligible when compared with raw milk levels (Erbersdobler *et al.*, 2002; Souci *et al.*, 2008).

In conclusion, the scientific evidence indicates that heating of milk modifies the structure of milk proteins, but that the changes in the proteins are related to their functional properties, such as solubility and emulsifying, and have no significant effect on their digestibility and nutritional properties (Efigenia M *et al.*, 1997; Claeys *et al.*, 2012).

4.2 VITAMINS

While milk is an important source of a range of vitamins, some are present in only very small amounts. In the overall context of the New Zealand diet, milk is a major source of vitamins A (in the form of retinol), B2 and B12, and to a lesser extent vitamins B1 and B3 (MoH 2011).

MacDonald et al (2011) conducted a systematic review to evaluate the impact of pasteurisation on vitamins present in raw milk. Forty different studies were included in the evaluation investigated the effect of pasteurisation on the following vitamins: A, B1, B2, B6, B12, C, E, and folate. Similar to the review of the FDA, no significant effect of pasteurisation was found in the concentration of B1 or B6 in milk, yet concentrations of B2, folate and vitamin C were significantly lower. Due to significant variability in the studies measuring vitamin A, E and B12, no quantification of effect could be measured, however it was noted that vitamin A concentrations were higher upon pasteurisation.

Table 1 highlights the contribution of vitamins and minerals to the RDI and also the impact of pasteurisation on the nutritional content of raw milk. Of the vitamins listed in the table only vitamin B2 and B12 would be considered a "good source" of the vitamin according to the Australian and New Zealand Food Standards Code regulation regarding nutrient content claims. Vitamin B2 concentrations were found to decrease the contribution to the RDI by 9% from 48% to 39% - and as such still contribute a significant proportion of the nutrient per serve. It should also be noted that in the context of the whole diet, such a difference would likely be minimal as the absolute difference in intake per serve is 0.12 mg and there are many other good sources of B2. Furthermore, low intakes of vitamin B2 in the New Zealand diet is very low (<5% of the population). In addition, it should be noted that vitamin B2 is generally considered heat stable but light sensitive (Jenness *et al.*, 1988; Fox and McSweeney 2003). This means that the vitamin B2 content will diminish in both raw and pasteurised milk on exposure to light, for example by storing in transparent/semi-transparent glass or plastic containers.

Although the change in vitamin B12 levels could not be quantified in the systematic review of MacDonald and colleagues (2011) the paper highlights that the magnitude of difference is likely to be small, ranging from 1.5×10^{-4} mg/L to 0.5×10^{-9} mg/L and is therefore unlikely to impact on total dietary intakes of vitamin B12.

Despite the findings that pasteurisation results in a significant decrease in vitamin C and folate in milk, the low concentration of these vitamins in milk means that pasteurisation has minimal impact on an individual's diet. For example, raw milk provides only 0.1 mg extra vitamin C per serve than pasteurised milk, which consequently has no impact on the percentage contribution to the RDI.

Table 1: Comparison of the nutrient content of pasteurised milk and raw milk* and the contribution of each to the RDI for adult males

		Nutrient content in pasteurised milk**			Nutrient content in raw milk		
Nutrient	**RDI***	**Per 1L**	**Per serve (258 mL)**	**% RDI per serve**	**Per 1 L**	**Per serve (258 mL)**	**% RDI per serve**
Vitamin A	900 ug	480 ug	124 ug	14%	lower	-	-
Vitamin B1	1.2 mg	0.3 mg	0.08 mg	7%	No difference	-	-
Vitamin B2	1.3 mg	2.0 mg	0.5 mg	39%	2.41 mg	0.62	48%
Vitamin B3	16 mg	8 mg	2.1mg	13%	-	-	-
Vitamin B6	1.3 mg	0.4 mg	0.1mg	8%	No difference	-	-
Vitamin B12	2.4 ug	3.4 mg	0.86 mg	36%	higher	-	-
Folate	400 ug	50 ug	12 ug	3%	62 ug	16	4%
Vitamin C	45 mg	10 mg	3 mg	7%	12 mg	3.1 mg	7%

* the nutrient composition of raw milk was derived from the systematic review of MacDonald and colleagues (2011)
** the nutrient composition of pasteurised milk was taking from the New Zealand Food Composition Tables values for "Milk, Fluid, Standard"(Crop and Food 2006)

4.3 MINERALS

Milk is a particularly good source of the minerals iodine, calcium and phosphorus. Claeys *et al.* (2012) evaluated studies on this topic and concluded that heat treatment appears to have no significant effect on the amount or bioavailability of calcium. A number of studies demonstrated that there is no impact of pasteurisation on milk mineral content and mineral bioavailability (Weeks and King, 1985; Zurera-Cosano *et al.*, 1994).

4.4 FATS

Heat treatment has no effect on milk fat amount or composition and for this reason research on this topic is minimal (FDA, 2011). Animal feed accounts for the major variations in the of fatty acid composition and the changes in the fatty acid profile observed after intense processing appear to be less relevant than feed and seasonal variations (Jensen *et al.*, 2002, Mattila-Sandholm & Saarela, 2003). Commercial heating, like pasteurisation, of milk does not affect milk lipids (Claeys *et al.* 2012).

Homogenisation, a process undertaken to prevent the cream layer from separating out of the milk breaks up the fat globules causing a reduction of the fat globule size and a concurrent increase in the milk surface area, thus favouring milk fat lipolysis. Homogenisation is a distinctly different process to pasteurisation. Research is ongoing to determine whether there is any physiological impact of homogenisation on human nutrition. (Perkin 2007; FDA 2011, Claeys *et al.* 2012).

As pasteurisation and homogenisation are two different processes with two different purposes, their effects have to be considered separately. Non-homogenised pasteurised milk is available in supermarkets and the effects of homogenisation are not considered further in this document.

5 Claim 2 “People with lactose intolerance can drink raw milk”

Lactose intolerance occurs in individuals who lack lactase (beta-galactosidise), the enzyme required to metabolise lactose to glucose and galactose. In most cases intolerance causes symptoms such as abdominal bloating and cramps, flatulence, diarrhoea, nausea, after consuming significant amounts of lactose.

All milk, whether raw or pasteurised, contains lactose and can cause reactions in intolerant individuals. However it is believed by some that raw milk does not cause the symptoms of lactose intolerance because it contains natural lactase enzymes produced by ‘beneficial’ bacteria in the raw milk which are destroyed during pasteurisation.

Lactase does not occur naturally in raw milk. Lactase- producing strains of bacteria potentially can be present in small amount in raw milk, but that their growth and hence lactase production, is inhibited at the refrigeration temperature used to store raw milk. The number of these bacteria and their activity are too limited to have any physiological effect for consumers. The destruction of these bacteria by heat treatment has no consequent net health effects (Claeys *et al.* 2012 and references therein).

Lactose intolerant consumers may be able to eat yoghurt and other fermented milk products without reactions because of the lower lactose content in the products. The fermentation process involved in making yoghurt which results in a lower lactose content involves inoculating the yoghurt with microorganisms *Streptococcus thermophilus* and *Lactobacillus bulgaricus* which are not found in raw milk..

Currently there is only one case-control study that has evaluated lactose intolerance and raw milk consumption. The authors did not find any significant association as the lactose intolerant participants reported symptoms after the consumption of both, raw milk and pasteurised milk and the severity of these symptoms were not significantly different (Korpela *et al.* 2005, MacDonald *et al.*, 2011). Further studies in this area are underway.

6 Claim 3 “Pasteurisation destroys/inactivates beneficial antimicrobial systems and enzymes”

6.1 BENEFICIAL MICROFLORA OF RAW MILK

Various benefits have been attributed to lactic acid bacteria present in raw milk. They could for example inhibit the multiplication of pathogens by producing bacteriocins (anti-bacterial substances) like nisin. Nisin, like most bacteriocins is produced only during the exponential growth phase (i.e. when conditions are warm and favour rapid growth) of *Lactococcus* organisms (Arauz *et al.*, 2009; Thomas *et al.*, 2000). As their growth and their biological activity are limited at the normal refrigeration temperature used to store raw milk the rapid growth needed for bacteriocin production is unlikely to occur. If substantial bacteriocin production occurs in raw milk it would suggest poor hygiene and poor refrigeration.

While pasteurisation kills bacteriocin-producing bacteria present in raw milk, bacteriocins that were produced before pasteurisation are heat-stable and will retain their activity. It is important to be aware that bacteriocins such as nisin tend to be effective against only some (gram-positive) bacteria and are generally not effective against the important milk borne pathogens such as Salmonella and toxin-producing strains of *Escherichia coli* which are gram-negative (Arauz *et al.*, 2009; Boziaris and Adams 1999).

Another benefit attributed to the bacteria occurring naturally in milk is that they are probiotics. Probiotic bacteria (specific strains belonging to *Lactobacillus*, *Bifidobacterium* and *Enterococcus* species), are described as health-promoting micro-organisms. The Food and Agriculture Organization of the United Nations (FAO) defines probiotics as "live microorganisms, which, when administered in adequate amounts, confer a health benefit on the host." Probiotic microorganisms must be of human origin in order to have an impact on human health (Ishibashi and Yamazaki, 2001, Teitelbaum and Walker, 2002). Most bacteria present in raw milk are not of human origin, as they have come from udder tissues, the dairy environment and milking equipment. Bifidobacteria in the gastrointestinal tracts of humans are different to those found in animals and thus the milk from animals. Moreover, bifidobacteria are inhabitants of the cow’s intestines not the udder. Raw milk collected using good hygiene practices should not contain bifidobacteria. Moreover, the presence of bifidobacteria in raw milk indicates faecal contamination and poor farm hygiene.

Lactobacillus species are generally considered to be probiotic and consumption of fermented dairy products containing a high quantity of Lactobacilli may aid the digestion of milk among lactose intolerant individuals. However, Lactobacilli typically are a small portion of the microflora of raw milk. To result in any beneficial effect, these probiotics need to be ingested in large quantities in order to survive the intestinal transit. It has been shown, that the ingested amount required to have an effect, needs to be 1000 to 10,000 times higher than the amount actually present in raw milk (Griffiths *et al.*, 2010; MacDonald *et al.*, 2011).

The reduction in the number of bacteria in milk by pasteurisation may have some minimal undesirable consequences. If bacterial spores (e.g. *Bacillus cereus* spores) present in raw milk, they will survive pasteurisation and can germinate, also vegetative bacteria may contaminate milk after pasteurisation (post-contamination). Presence of high amount of lactic acid bacteria can provide an inhibitory effect on pathogen growth. However, recent research (Withers and Couper, 2012) showed that pathogens introduced in milk had increased lag period due to the presence of lactic bacteria, but after the extended lag period achieved similar growth rates to those observed without lactic bacteria present. In any case the levels of lactic acid bacteria vary in raw milk and while delaying growth, they cannot kill disease causing bacteria.

6.2 ANTIMICROBIAL SYSTEMS

Raw cow's milk may contain systems with antimicrobial properties that inhibit the growth of microorganisms in the milk. These systems include enzymes (lactoperoxidase, lysozyme, xanthine oxydase) and proteins (lactoferrin). However none of these are present at concentrations high enough to eliminate pathogens and their activity is limited at the refrigeration temperatures used to store raw milk (Griffiths, 2010). Note that in case of lysozyme and lactoferrin high concentrations in milk would indicate the cow's compromised health condition, simply due to cow's elevated natural defence system (FDA, 2011).

Studies showed that commercial pasteurisation causes no significant loss of lactoferrin's antimicrobial activity (Sanchez *et al.*, 1992). More recently Spanish researchers studied the effect of different heat treatments on the antimicrobial activity of bovine lactoferrin (bLF) against the pathogens *Escherichia coli* O157:H7, *Salmonella enteritidis* and *Listeria monocytogenes*. They have shown that the heat treatments lower than 85˚C for 10 minutes (as used in pasteurisation) did not affect the antibacterial activity of bLF. (Conesa *et al.*, 2010). Lysozyme is a heat stable enzyme (Fox and Kelly, 2006) so is not significantly reduced during pasteurisation. Furthermore, normally the concentration of lysozyme in bovine milk is very low (Silanikove *et al.*, 2006) and only increases when cows are infected.

Lactoperoxidase is one of the most heat-stable enzymes found in bovine milk and it is not destroyed by commercial pasteurisation conditions (Kussendrager and van Hooijdonk, 2000). Lactoperoxidase contributes to the bacteriostatic (i.e. stops bacterial growth) activities of milk when activated by thiocyanate ion (SCN-) in the presence of hydrogen peroxide (H_2O_2), the components that naturally exist in tears, saliva and gastric juices (Arques *et al.*, 2008). Artificially activated Lactoperoxidase can be used for preservation of raw milk. CODEX allows the use of activated lactoperoxidase to prevent spoilage during collection and transportation of raw milk when adequate refrigeration is not available (Codex CAC/GL 13-1991). This treatment of raw milk does not substitute pasteurisation. FAO/WHO clearly states that the purpose of lactoperoxidase system (LP-s) is "not to render milk safer for consumption" and that "the safety of milk is only achieved through a combination of good hygienic practices and heat treatment of milk, independent of LP-s." (FAO/WHO, 2005, FDA 2011; Claeys *et al.*, 2012; Sheehan, 2010).

Xanthine oxidase (XO) is an enzyme found on milk fat globule membrane with an antimicrobial role based on XO's ability to catalyse reactions that generate highly reactive oxygen and nitrogen species which are bactericidal and bacteriostatic (Stevens *et al.*, 2000; Harrison, 2006). It has also been hypothesized that the antimicrobial effect is derived from the formed hydrogen peroxide that participates in the lactoperoxidase system. However, the exact mechanisms involved in the antimicrobial phenomena are still unclear and complex (Harrison, 2006). Studies indicated that XO is the most heat stable milk fat globule membrane enzyme and retains its activity after exposure to the regular pasteurisation process. (Andrews *et al.*, 1987; LeJeune et al, 2009).

Overall there is little evidence that "good" bacteria or other components of raw milk reduce pathogen numbers. This is supported by the observation that live bacterial pathogens are routinely found in bulk tanks of raw milk on farms. (Jayarao *et al.*, 2001, Olivier *et al.*, 2005, van Kessel et al, 2011, Hill *et al.*, 2012).
Pasteurisation does not significantly reduce the biological activity of naturally occuring antimicrobial components of milk. In any case components do not appear to be sufficiently

active to reduce vegetative pathogens to the safe levels which can be achieved by pasteurisation.

6.3 DIGESTIVE ENZYMES

Heat treatment may inactivate some milk enzymes like proteases and lipoprotein lipase (LPL). There is no evidence of physiological role of these enzymes in human protein digestion. Protease and lipase that help the process of digestion are proteins secreted by organs in the human gastrointestinal tract. Although raw milk contains various protease and lipoprotein lipase, there is no described role of milk proteases in human protein digestion or LPR in lipids digestion. Milk enzymes, like other proteins, are denaturated in the acid gastric environment and digested by human proteases secreted in the gastrointestinal tract. Therefore, inactivation of proteases and LPR by pasteurisation has no impact on the nutritional value of milk (Olivecrona *et al.*, 2003; FDA, 2011)

7 Claim 4 "Consuming raw milk helps the development of a strong immune system and prevents the development of allergies, asthma and atopy. People with these conditions will have worse symptoms if they drink pasteurised milk"

7.1 BENEFICIAL IMMUNOGLOBULINS (ANTIBODIES) IN MILK

It is claimed that pasteurisation destroys immunoglobulins present in raw milk and that these bovine immunoglobulins could have health benefits when ingested. Bovine immunoglobulin is primarily secreted in the colostrum, so the concentration of immunoglobulins in bovine milk is low, too low for direct consumption from milk to be physiologically significant for humans (Hurley, 2003; Fox, 2003).

The predominant fraction of immunoglobulins in bovine milk is IgG which is heat stable. A study conducted by Mainer *et al.* (1997) reported no impact on the level of IgG by Low Temperature Long Time pasteurisation (63°C for 30 min) and only 1% denaturation by High Temperature Short Time pasteurisation (72°C/15s). In an older study Kulczychi *et al.* (1987) reported the possibility that pasteurisation might enhance the receptor binding activity by aggregation of the bovine IgG, which suggests even better immunological function for pasteurised milk compared to raw milk.

7.2 POSITIVE EFFECTS IN PREVENTING ALLERGIC CONDITIONS AND STIMULATING IMMUNITY

Possible positive effects of raw milk consumption on allergic conditions have been attributed to a variety of factors (Braun-Fahrlaender and von Mutius, 2011; Griffiths, 2010). These include:

- unprocessed farm milk is generally richer in unsaturated fatty acids than commercial milk which is standardised for fat content;
- the presence of 'healthy' milk proteins (e.g. bioactive peptides and allergy-causing structures);
- the intake of non-infectious microbial components (e.g. endotoxins), harmless strains of, or very small numbers of pathogens in the raw milk creating a higher immunity to these pathogens;
- the presence of immunoglobulins (see above).

The consumption of whole (not skim, not homogenised) milk is associated with a decreased prevalence of hay fever and asthma. This is in line with recent studies which indicate a protective effect of foods rich in fatty acids (Kitz et. Al., 2010; Li *et al.*, 2013). Pasteurisation has no effect on total fat content and fatty acid composition (saturated, monounsaturated, polyunsaturated) (Romeu-Nadalet al, 2008). Commercial milk is typically homogenised to increase physical stability, i.e. to prevent gravity separation of fat. Milk fat globules are reduced in size from 3 to 10 micron to less than 2 micron in diameter after typical homogenisation.

Lipids and protein components of milk have been shown to be influenced by type of farming, feeding practice and farm altitude rather than by pasteurisation (Braun-Fahrlaender & von Mutius, 2011, Claeys *et al.* 2012, Jensen, 2002).

Endotoxins are generally heat-stable toxic materials which are an intrinsic part of the outer membrane of gram negative bacteria. It was found that endotoxin levels in raw milk samples compared with commercial pasteurised milk samples did not differ significantly (Gehring *et al.*, 2008). The study concluded that difference between farming and non-farming families cannot be explained by elevated level of endotoxins in raw milk.

Case studies from the 1980s suggested that repeated consumption of raw milk contaminated with pathogens provided some immunity against *Campylobacter* but not other milk-borne infections (Blaser *et al.*, 1987). Although further studies related effect of increased immunity against *Campylobacter* infection to early life exposure to in-farm environment, not necessary drinking raw milk (McBride & French, 2006).

It was shown that protein quality and protein digestability of raw and pasteurised milk are the same (Andersson and Oste, 1995, Lacroix *et al.*, 2006 , Lacroix et al, 2008). This suggests that pasteurisation does not change the allergenicity of milk proteins. Physiologically active peptides derived from milk proteins are inactive within the parent protein molecule and are liberated by gastrointestinal digestion of milk.

7.3 EVIDENCE FROM CONSUMPTION STUDIES[1]

Recently Braun-Fahrlaender and Mutius (2011) published a review of scientific studies conducted from 2000 to 2010 to investigate the association of consumption of farm milk and allergic diseases. A number of epidemiological studies suggest that early-life exposure to unprocessed cow milk could reduce the risk for developing asthma, allergies, hay fever and atopy like eczema (Loss *et al.*, 2011; Waser *et al.*, 2007; Perkin & Strachan, 2006; Wickens *et al.*, 2002; Barnes *et al.*, 2001; Riedler *et al.*, 2001). There is however a considerable variation in the research rigour and quality of these studies. Possible protective effect of raw milk consumption is often masked by presence of other factors and milk status at the point of consumption is not clearly stated. That is, the studies do not generally indicate whether the raw milk was scalded, or otherwise heat treated in the home before it was consumed. Most of the studies also did not offer a direct comparison with heat treated milk. Moreover, it is not always clear if the observed reduction in risk of developing asthma and other allergies is completely independent of other factors such as the exposure to a farm environment or to animals (Claeys *et al.*, 2012).

The Prevention of Allergy—Risk Factors for Sensitization Related to Farming and Anthroposophic Lifestyle (PARSIFAL) study has been cited as a confirmation of positive association between raw milk consumption and reduction of asthma and allergy. However, in this study it was estimated about half of the farm milk was boiled before consumption and the authors of the study also stated that the study did not allow evaluation of the effect of pasteurised vs. raw milk consumption because no objective confirmation of the raw milk status of the farm milk samples was available (Waser *et al.*, 2007).

Of the studies reviewed by Braun-Fahrlaender and Mutius (2011), two (Radon *et al.* 2004 and; Remes et al 2003) reported no protective effect of farm milk consumption on atopy. Moreover, Radon showed that only the combination of unpasteurised milk consumption and regular visits to animal houses was protective. Out of their review Braun-Fahrlaender and Mutius concluded that although epidemiological evidence exists that suggests a protective role of unprocessed cow's milk consumption on the development of asthma, hay fever and atopic sensitisation, the underlying mechanisms are not yet understood and the consumption

[1] Additional analyses of the literature on raw milk and allergic diseases can be found on the Food Standards Australia New Zealand website http://www.foodstandards.govt.nz/code/proposals/documents/P1007%20PPPS%20for%20raw%20milk%201AR%20SD5%20Nutrition%20Assessment.pdf

of raw milk cannot be recommended as a preventive measure for allergic diseases (Braun-Fahrlaender and Mutius, 2010).

To clarify the mechanisms of action and constituents of farm milk responsible for the protective effect, Loss and co-researchers further investigated the farm milk effect in the comprehensive GABRIELA study. The study confirmed that raw milk consumption is inversely associated with asthma, atopy and hay fever independent of other farm exposures and that the protective effect of raw milk on asthma, but not atopy, might be associated with the whey protein fraction of milk. Further it was confirmed that neither total bacterial counts nor the total fat content of milk were related to asthma and atopy. But the mechanisms underlying the protective farm milk effect is still not fully understood. Loss and colleagues stated in their final conclusion “on the basis of the current knowledge, raw milk consumption cannot be recommended because it might contain pathogens” (Loss *et al.*, 2011).

8 Conclusion

A number of epidemiological studies suggest that early-life exposure to unprocessed cow's milk together with other factors may reduce the risk for developing asthma, allergies, hay fever and atopy like eczema. However, these studies only report association between raw milk consumption and allergy sensitisation and do not identify cause-effect relationships. Until the mechanisms underlying the protective 'farm milk effect' has been clarified, raw milk consumption cannot be recommended because raw milk may contain pathogens which can cause serious illnesses.

9 Summary

The following table illustrates a summary of the claimed benefits and evidence relevant to the claim

Claimed Benefit of raw milk	Conclusion drawn from the scientific evidence available
"Higher nutritional value"	*Proteins and amino acids* • Heating modifies structure of some (mainly whey) proteins but has little effect on digestibility and nutritional properties of milk proteins. • Effects on amino acids negligible. *Vitamins* • Effect of pasteurisation on the vitamin content of milk is very low from a nutritive point of view. Only heat sensitive vitamins are affected by the pasteurisation process, with small decreases observed in the vitamin B2, B12, C and folate content of pasteurised milk, but concentrations of these vitamins are naturally low in milk. *Minerals* • Pasteurisation has no negative effect. *Fat* • Pasteurisation has no negative effect.
"Can be consumed by people with lactose Intolerance"	A case-control study, evaluating lactose intolerance and raw milk, did not show any significant difference in the frequency or duration of symptoms Raw milk may contain lactase-producing bacteria, but the quantity is too low to have a beneficial effect on lactose digestion. Refrigeration required for raw milk storage inhibits growth of lactic acid bacteria and, hence, the lactase production. The destruction of these bacteria by pasteurisation therefore has no net health effect.

"Antimicrobial systems and enzymes have not been destroyed"	Raw milk may contain the following antimicrobial factors • *Lactic acid bacteria and bacteriocins e.g. Nisin* – Growth, hence, production of nisin too low to result in a positive effect under refrigerated conditions and only effective against gram positive pathogens. Pasteurisation can kill lactic bacteria, but do not destroy bacteriocins already present in the milk. • *Lactoferrin* – Concentration is too low in mature bovine milk to be effective and pasteurisation causes no loss of antimicrobial activity of lactoferrin • *Lysozyme* – Concentration is usually low and lysozyme is heat stable and is not destroyed by pasteurisation. • *Lactoperoxidase* – Lactoperoxidase is heat stable and is not destroyed by pasteurisation. • *Xanthine oxidase* - is the most heat stable milk fat globule membrane enzyme. *Enzymes* Pasteurisation inactivates enzymes like protease and lipase but these enzymes have no physiological role in human digestion. Pasteurisation may lower the activity of some enzymes minimally, but their activity is anyway limited at refrigeration temperatures used to store raw milk
"Enhances the immune system"	Concentration of bovine immunoglobulins is too low to be of physiological significance and pasteurisation has no or low impact on their level.
"Prevents the development of asthma, allergies and atopic diseases"	Epidemiological evidence suggests some protective role of unprocessed cow's milk consumption on the development of asthma, hay fever and atopic sensitization. But underlying mechanism and constituents are still not clarified; hence, evaluation of pasteurisation effect is not exactly determinable. Further research required.

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