A Summary of the Safety and Nutritional Value of Organic Food

Prepared for

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1. Nutritional value

There are many studies comparing conventionally and organically produced food in terms of nutritional value, however most were poorly controlled and limited their analyses to a few key components (Blaine et al., 2002). Further, comparisons between studies are generally not valid due to a wide range of factors including genetics, climate, regional weather variations, irrigation and post-harvest handling which can influence the composition of crops. Attempts have been made to control for these factors by setting up farm models and extending study to multiple years. Literature indicates that nutritional differences existing between organic produce and conventional produce are minimal.

- The benefits of simply eating more fresh fruits and vegetables far outweigh any negligible benefits that could be obtained through organic food products and any risks that may be posed by substances such as chemical pesticides (Ames and Gold, 1997).
- Few of the studies examined accounted or controlled for transportation and storage effects.
- Warmanand Harvard (1996) examined the mineral content of potatoes, sweet corn, carrots and cabbage. A slightly higher mineral content in the organic potatoes and sweet corn were revealed in addition to slightly lower mineral content in organic cabbage and carrots.
- A two year Canadian study on apples (DeEll and Prange, 1993) found certain elements were higher in the conventionally grown/fertilized vegetables while other elements in the organically grown/fertilized crops were higher.
- A 150 study review by Woese et al. (1997) found similar variation in the majority of studies examining minerals and trace elements. No clear differences between the two farming systems were shown.
- Bourn and Prescott (2002) reviewed nutritional data and demonstrated that with the possible exception of nitrate, there is no strong evidence organic and conventional foods differ in the concentration of various nutrients. Lack of recognition of the bioavailability of nutrients in the studies was also indicated.
- Among more recent studies, higher levels of Vitamin C, carotenoids and polyphenols were reported in the fresh matter of organic tomatoes (Caris-Veyrat et al., 2004). Another study showed that lettuce, collards and pac choi did not exhibit significant differences in levels of phenolic (Young et al., 2005)
- Over three years, Chassy and colleagues (2006) studied antioxidant properties including total phenolics, ascorbic acid, several flavanoid aglycones (quercetin, kaempferol and luteolin) and percent soluble solids in two varieties of tomatoes and bell peppers that were grown using certified organic and conventional growing models. While there was significant variation year to year, only percent soluble solids (10%) and kaempferol were significantly higher in organic Ropreco tomatoes.

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2. Food Safety

Microbiological

Foodborne illness epidemiological data has shown that fresh fruits and vegetables, produced either conventionally or organically, are common vehicles for the transmission of foodborne disease. Empirical evidence of the safety and relative risks of organic produce is limited. Organically produced fruits and vegetables have not been proven to be any more or less safe than conventionally produced fruits and vegetables. Certification as “organic” does not require the grower to use production practices that eliminate, reduce or control the presence of pathogenic microorganisms, although some organic standards address microbiological food safety issues indirectly.

- Microbiological sampling of organic produce from supermarkets in both the U.K. (Sagoo et al., 2001) and Northern Ireland (Mahon & Wilson, 2001) found only minor contamination using indicator organisms *E. coli* (in 0.5% of samples) and *Aeromonas spp.* (in 34% of samples). Neither study conducted a comparative study on conventional produce precluding both researchers from drawing conclusions as to the comparative safety or risks of organic and conventional produce. However, both did conclude that the microbiological risks associated with organic produce were not greater than for conventional produce.
- A similar U.S. survey found detection of *E. coli* and *salmonella spp.* were essentially the same on conventional and organic produce (Doyle, 2001) also indicating that organic produce carries the same risks of conventionally grown produce.
- Microbiological analyses of a multitude fresh fruits and vegetables produced by organic and conventional farmers in Minnesota were performed to determine the coliform count and the prevalence of *E. coli*, *Salmonella*, and *E. coli* O157:H7 (Mukherjee et al., 2004). Results from samples of 32 organic growers and 8 conventional growers in this study confirmed previous study findings that organic fruits and vegetables appear to be no more susceptible to pre-harvest contamination than conventional produce.

Mycotoxins

Low concentrations of mycotoxins have been found to be acutely toxic as well as carcinogenic to both humans and livestock (Joint FAO/WHO Expert Committee on Food Additives, 2001). Fungal infections are often secondary to other infections or insect damage. It has been hypothesized that organically grown plants would contain higher mycotoxin levels due to increased insect damage. Organic advocates have argued that organic crops would be lower in mycotoxins because they are healthier plants. While only a few comparative studies have been conducted, findings have been conflicting and inconclusive.

- Bodenmüller (2001) reviewed several mostly german studies on mycotoxin content in organic, conventional and genetically engineered crops. A few studies reported significantly higher mycotoxins in various organic foods (apple juice, rye, wheat) while another reported 90% lower concentrations of fumonisin and 75% lower aflatoxin concentrations in genetically engineered Bt corn.
- A recent study by Ariño and others (2007) indicated that while fuminisin mycotoxins were lower in organic corn than in conventional corn (.17% and .21% respectively), there is no tenable evidence that the differences observed would lead to an objectively measurable effect on consumer health.
- Despite the relative presence of mycotoxins being the subject of several studies and much debate, Magkos and friend's (2006) review of the evidence cannot conclude that either type of farming leads to an increased risk of contamination.

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3. Organic Pesticides and Inputs

Trace Elements and Elemental Compounds

Many elements including copper, boron and iron can serve a dual role in agriculture as a required nutrient and as a pesticide. Trace element toxicities occur in all living organisms and consequences have been described in crops, livestock and humans (Gupta and Gupta, 1998). Relative toxicity, tolerance and requirements vary greatly amongst organisms. Agricultural use of trace elements and their derivatives as pesticides and fertilizers have been shown to increase soil and water levels (WHO, 1998a; WHO 1998b; WHO, 2001). Acute toxicity of these substances is generally well documented, but the availability of realistic chronic toxicity studies is limited. Bioavailability is important in both deficiency and toxicity.

- It has been demonstrated that planktonic algae and crustaceans which help form the basis of aquatic food webs, are highly sensitive to free copper levels; hence increased levels of bioavailable copper used in agricultural chemicals (copper sulphate, copper oxychloride) are likely to dramatically affect freshwater ecosystems (de Oliveira-Filho et al, 2004;Le Jeune et al, 2006). Higher aquatic organisms including rainbow trout and tadpoles are also susceptible to increased copper concentrations and have been studied extensively (Flemming and Trevors; 1989, WHO, 1998a; Nemscok and Hughes, 1988; Ferreira et al, 2004). Humans have exhibited gastrointestinal effects from single and repeated ingestion of drinking water containing high copper concentrations and liver failure has also been reported following chronic ingestion of copper (WHO 1998a).

- Boron toxicity in plants most often results from soils that have been exposed to boron-contaminated irrigation waters or excessive application of boron-rich fertilizers (Nable, 1997; WHO, 1998b; Parks and Edwards, 2005). While toxicity in aquatic organisms varies, studies have shown adverse reproductive and developmental effects in rainbow trout (Parks and Edwards, 2005; WHO 1998b). The majority of toxic effects reported in humans are occupational and are acute or short-term (WHO, 1998b).
- Elevated levels of Zinc are known to cause homeostatic deficiencies for other elements such as copper and other nutrients (WHO, 2001; De Schamphelaere, 2004). While acute toxicity and deficiencies are well documented, there are important gaps in research particularly in chronic marine toxicity (WHO, 2001).
- Studies of chronic elevated iron in humans and animals can lead to tissue damage with suggested links to brain damage and cancer (Gurzau et al., 2003). Vuori (1995) reviewed the effects of increased iron load on river ecosystems and reported direct toxic effects and indirect toxic effects such as disturbing the normal metabolism and osmoregulation in aquatic organisms.

Botanical Pesticides

There are only a few botanical pesticides that are registered for use within Canada and are suitable for organic crop production. Rotenone and nicotine that do not have synthetic contaminants are permitted for use, however there are no pyrethrum products currently available that do not have synthetic contaminants (NSC, 2006; Isman 2006). Active ingredients in botanical pesticides can be as toxic as synthetic pesticides in their pure form, but formulated products are usually considered much less toxic. There is little research on chronic exposure of these chemicals since the persistence is generally short due to photodegradation.

- Rotenone is readily oxidized on soil and plant surfaces to less toxic products; however its high acute toxicity to aquatic organisms mean surface waters must not be contaminated (WHO, 1992). The absorption of rotenone in some treated crops (e.g. olives) could increase its persistence because normal photodegradation cannot occur (Cabras et al., 2002). The appearance of Parkinson's Disease features in rats chronically exposed to rotenone has led to questions about its safety to mammals and humans (Betarbet, 2002; Isman, 2006).
- Pyrethrins are sensitive to UV light limiting their outdoor use. This has led to the development of synthetic derivatives called "pyrethroids" which are not suitable for organic production (Isman, 2006).
- Nicotine causes symptoms of poisoning similar to banned organophosphate and carbamate insecticides. Its extreme toxicity to mammals and rapid dermal absorption by humans has led to its declining use (Isman, 2006).

Biological Organisms

Biological organisms which benefit plant production are permitted for use in growing organic produce provided they are not developed through genetic engineering. *Bacillus thuringiensis*, spinosad (a secondary metabolite of *Saccharopolyspora spinosa)* and the granulosis virus are examples of beneficial organisms which have low acute toxicity to mammals and humans (Extonet, 1994; Cleveland et al., 2001; EPA, 1995). While strains of the granulosis virus are target specific, *B. thuringiensis* and spinosad are considered broad spectrum insecticides and may affect non-target organisms. Strains of *B. thuringiensis* dominate the biopesticide market accounting for up to 90% of biopesticides (Lopez et al., 2005). Despite low risks, care should be taken to avoid contamination of surface water.

- While toxicity to humans, mammals, aquatic organisms and most non-target insect species is low, *Bacillus thuringiensis* ssp. *thuringiensis* and *kurstaki* have been demonstrated to have adverse effects on honeybees which include mortality (WHO 1999).
- Spinosad is considered to have high acute toxicity to several bee species and mollusks. Cleveland et al. (2001) argue that these acute toxicities are unrealistic due to persistence of treatment and spinosad's short half-life. A later study by Morandin et al. (2005), demonstrated developmental effects in honeybees which reduced the foraging capabilities necessary for prolonged colony health under more realistic settings.

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