SUBMISSION

TO

FOOD STANDARDS AUSTRALIA & NEW ZEALAND

APPLICATION A1039

LOW THC HEMP AS A FOOD

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Executive Summary

Food Standards Australia & New Zealand (FSANZ) has received an application for approval of low THC hemp as a food. FSANZ has now invited public comment via a Consultation Paper dated 15 March 2011.

The IHAV hereby recommends that low THC hemp be approved as a food.

No contrary scientific or quantitative data has been produced to refute the previous FSANZ recommendations on hemp food. Previous studies carried out by FSANZ have honoured the objectives of FSANZ as set out in the Food Standards Australia New Zealand Act 1991. The primary objectives set out in section 10 of that Act are in Appendix A for ease of reference.

The Ministerial Council has previously rejected hemp food because of an unsubstantiated view that consumers associate hemp with marijuana. In other words, political motivation has prevented Australians being able to choose a nutritionally beneficial addition to their diets.

In 1998, Victoria was the first Australian State to legislate for farmers to grow industrial hemp, under a strict licensing regime. Twelve years later and all other States, with the exception of South Australia, have passed similar legislation. However, the industry in Victoria and elsewhere in Australia has not progressed. This is primarily because it is currently illegal to sell hemp for human consumption. Conversely, licensing was also introduced in Canada in 1998 and the hemp industry in that country is now valued at approximately $500 million, predominantly in food, and the figure is growing exponentially.

The IHAV was established to give a voice to the hemp industry and this submission focuses on the uses and benefits of hemp, as opposed to any perceived relationship or association with marijuana. Just as it is legal to sell poppy seeds for human consumption in Australia (with minimal traces of opiates), it should also be legal to consume hemp seeds and hemp seed products (with minimal traces of tetrahydrocannabinol (THC)).

Introduction

The IHAV is a non-profit organisation committed to representing growers, researchers, retailers and supporters. We are dedicated to education, industry development, and the accelerated expansion of the market for industrial hemp. Approval of industrial hemp as a food is essential.

Objectives of IHAV include:

- To provide an alternative and profitable cropping option for growers by facilitating the development of an industrial hemp industry in Victoria.
- To establish, administer and develop State and national lobby groups for interface with government agencies.
- To facilitate knowledge exchange and information dissemination.
- To form a foundation and ongoing commitment for a national Australian hemp association.
- To represent industry interests in matters of quarantine, legislation and other grower, producer and end user issues, providing a strong industry voice.
- To adopt a firm stance against genetic modification of hemp crops.
- To increase public awareness of the uses and benefits of industrial hemp-based sustainable products.
- To foster a national objective of developing an environmentally and economically sustainable industrial hemp industry, creating markets and healthy competition.
- To support the development of new employment opportunities.

Throughout this submission, low THC *Cannabis sativa* is referred to as hemp. Where applicable, comparisons may be made to high THC *Cannabis sativa* which is referred to as marijuana. This is a distinction made widely throughout the world. The word "marijuana" was adopted by United States lobbyists for big business, in a scare campaign to thwart activity in the hemp industry – hemp was perceived as a threat to nylons, plastics, pharmaceuticals, paper, cotton and many other industries.

Several scholars have claimed that the Marihuana Tax Act 1937 was passed in order to destroy the hemp industry, largely through the efforts of businessmen Andrew Mellon, Randolph Hearst, and the Du Pont family. With the invention of the decorticator, hemp became a very cheap substitute for the paper pulp that was used in the newspaper industry. Hearst felt that this was a threat to his extensive timber holdings. Mellon, Secretary of the Treasury and the wealthiest man in America, had invested heavily in DuPont's new synthetic fibre, nylon, and considered its success to depend on its replacement of the traditional resource, hemp.

Big business is therefore the reason for the perpetuation of the scare campaign against hemp. However there are many reasons for those businesses to adopt hemp as a commodity and redeploy their resources to the hemp industry. Whilst some of these businesses may deem hemp as a competitive threat, there is no need for mutual exclusivity.

Hemp has been used as a food throughout the world for millennia. It is the best plant-based natural source of omegas 3, 6 and 9 available for human assimilation.

Jack Herer, author of 'the Emperor Wears No Clothes", says: "Of all the 300,000 species of plants on Earth, no other plant source can compare with the nutritional value of cannabis/hemp/ marijuana seeds. It is the only plant on Earth that provides us with the number one source, and the perfect balance of essential amino acids, essential fatty acids, globulin edestin protein, and essential oils all combined in one plant, and in a form which is most naturally digestible to our bodies."

Every other industrialised nation in the world allows low THC hemp for human consumption. It is time Australians were able to benefit from legalisation of the sale of low THC hemp products.

FSANZ has estimated that up to 850 hours of work are required for the assessment of the current application (A1039). This is simply replicating the work that was carried out by FSANZ when they received application A360 in 1998. After four years, FSANZ recommended to the Ministerial Council that hemp be accepted as a food. The Ministerial Council rejected the application without any scientific or research basis in support of their rejection. Their decision is reported on the web site of the Food Regulation Secretariat:

> "Ministers decided to retain the total prohibition on the use of industrial hemp as a novel food. Ministers believe that the use of hemp in food may send a confused message to consumers about the acceptability and safety of *Cannabis*. There are also concerns about law enforcement issues, particularly from a policing perspective there are difficulties in distinguishing between high THC *Cannabis* and low THC hemp products."
>
> (http://www.health.gov.au/internet/main/publishing.nsf/Content/foodsecretariat-communiques-02_24may.htm)

The rejection may simply have been politically motivated. This is clear in the above statements, having been repeatedly iterated in writing to IHAV members by Health Ministers from both major parties in the past three years.

This submission will support the argument to legalise hemp food. This will be achieved by:

1. Addressing the objectives of FSANZ set out in section 10 of the FSANZ Act 1991;
2. Addressing the two reasons given by Health Ministers after Application A360 was defeated; and
3. Responding to 18 questions posed by FSANZ in their Consultation Paper.

Essentially, however, none of the research or scientific evidence since the extensive assessment carried out by FSANZ over the four year period 1998-2002 (summarized by FSANZ in its Consultation Paper for the current application A1039) has changed and the nutritional benefits cannot be disputed.

We submit that approval must now be given for Australians to benefit from adding hemp food as another food choice – to join the rest of the world. There is no basis for hemp not to be legalized as a food in Australia and New Zealand

FSANZ FUNCTIONS & OBLIGATIONS UNDER THE FSANZ ACT 1991

Section 18 of the FSANZ Act 1991

(1) Objectives (in descending priority order) of the Authority in developing or reviewing food regulatory measures and variations of food regulatory measures are:

(a) the protection of public health and safety

"Protection" is a wide reaching term and is not itself defined in the FSANZ Act. "Protection" can include taxation measures, health advisory notes and warnings.

The United Nations' World Health Organization ("WHO") defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." (WHO Definition of Health Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, 1946)

According to the WHO website (http://www.who.int/topics/food_safety/en/):

> "Food safety encompasses actions aimed at ensuring that all food is as safe as possible. Food safety policies and actions need to cover the entire food chain, from production to consumption".

After far as botulism, salmonella and other food-borne diseases are concerned, food regulations are already well in place. Our food regulations already effectively cover processing and packaging of oil and seed products for human consumption.

More and more, we are learning from health authorities, medical practitioners and the media about the benefits of "good" fats versus "bad" fats and that a higher intake of "good" fats in the right balance is essential to good health.

John Roulac, an American-based nutritionist, best summarises these needs in the article reproduced in Appendix B: "The Nutritional Benefits of Hemp".

Canadian scientist, Dr Udo Erasmus, who holds a PhD in nutrition, has international recognition for his work on the health benefits of "good" fats. In his book "Fats that Heal Fats that Kill" (1993), compares flax seed oil (which is widely available in Australia) with hemp seed oil (which is widely available everywhere else *except* Australia):

> "While flax oil is useful for treating degenerative diseases, it is too w3-rich (about 4 times as much w3 as w6) to be used exclusively in the long term. One can develop w6 deficiency by using *only* flax oil for too long. While it took me about 2 years to end up with thin, papery-feeling skin that dried out and cracked easily, w6 deficiency could develop in as short a time as 10 to 16 months of *exclusive* use of flax oil ... Hemp seed oil can be used over the long term to maintain a healthy EFA balance without leading to either EFA deficiency or imbalance. This is because iT contains w6 and w3 EFAs in a better long-term balance: 3 to 1. In addition, it contains almost 2% GLA, the w6 derivative that is a key active ingredient in evening primrose and borage oils."

Flax seed oil is already widely available in Australia. Hemp seed oil should be equally available. Australian consumers should have the choice.

FSANZ has a duty to promote and protect public health and safety. By recommending to the Ministerial Council that hemp food be accepted, FSANZ has acted responsibly in the past and should continue to do so by again recommending hemp be approved as a food. Consumers in this democratic society should have the right to choose what food they consume, subject to ensuring that there is no inherent danger in that consumption. The nutritional benefits of hemp are clear and FSANZ has thoroughly reviewed them. There is therefore no valid reason for hemp to be prohibited as a food on health and safety grounds or, indeed, any grounds.

In comparison with some other contentious foods, such as genetically modified canola or genetically modified soy beans, there is no hemp crop worldwide that is the result of genetic modification and there is a strong commitment from the industry that this stance be maintained, thus becoming another layer of protection for public health.

Lester Grinspoon of Harvard Medical School has testified before US Congress and has been an expert witness in various legal proceedings regarding drugs and their content and effects. In relation to the billions of dollars spent by the US to discredit the uses and benefits of hemp, he says "this vast research enterprise has completely failed to provide a scientific basis for prohibition".

(b) the provision of adequate information relating to food to enable consumers to make informed choices

Labelling appears on all food products to ensure that consumers are informed about their choices (the exception to this is the currently contentious lack of labelling for genetic modification, However, hemp is not affected by this because there is no genetic modification of hemp crops worldwide). If approved as a food, labelling on hemp foods will need to comply with the existing statutory labelling requirements. Below is an example of the labelling which appears on New Zealand hemp seed oil, produced for human consumption by Oil Seed Extractions, Ashburton, New Zealand.

Product: Hemp seed Oil

Packaging: 250ml Bottle

Nutrition Information Panel

Serving size: 15ml (1Tbsp) Servings per Package: 17	Average Quantity Per Serving	Per 100 g (= 108 ml)
Energy	555kJ	3996kJ
Protein	<1.0g	<1.0g
Fats, (total fats)	14.0g	100.0g
Polyunsaturated	10.8g	78.0g
- Omega-3	2.8g	20.0g
- Omega-6	7.6g	55.0g
- GLA	0.4g	3.0g
Monounsaturated	1.6g	12.0g
Saturated	1.5g	10.0g
Carbohydrate, total	<1.0g	<1.0g
Sugars	0.0g	0.0g
Sodium	0.0g	0.0g

A copy of the Nutritional Analysis for the above is attached as Appendix C. This product is legally sold in New Zealand for human consumption. It has been legal to do so since 1984 (27 years).

In addition to food labelling, it is noted that, from time to time, FSANZ publishes articles and leaflets related to particular food issues. One such current pamphlet, "Mercury in fish" advises consumers on the consequences of high intake of some deep sea fish. In this pamphlet, FSANZ warns that "high levels of methylmercury can damage the nervous system … populations that eat large amounts of fish have reported a link between consumption of fish by mothers and subtle developmental delays in their children". Apart from giving consumers a wider choice for dietary intake of essential fatty acids, whether it is because they choose to be vegan or vegetarian, or they simply want variety, balance and good health, FSANZ has the opportunity and perhaps even the obligation to point out alternatives to fish and fish oil. The ideal alternative is hemp seed products.

(c) the prevention of misleading or deceptive conduct.

Section 52 of the Trade Practices Act 1974 states that:

> "(1) A corporation shall not, in trade or commerce, engage in conduct that is misleading or deceptive or is likely to mislead or deceive.
> (2) Nothing in the succeeding provisions of this Division shall be taken as limiting by implication the generality of subsection (1)."

The Trade Practices Act applies to corporations; various State laws apply similar logic to individuals. It is difficult to see the function for FSANZ in enforcing the provisions of the Trade Practices Act, except perhaps in providing evidence to support a possible contravention of that Act. All traders must comply with corporate and consumer laws in each State and Territory. Hemp should not be singled out for specific treatment under these laws. The potential to mislead is evident across all commercial sectors and cannot be limited to hemp.

It is perhaps even misleading and/or deceptive for the Ministerial Council to have denied consumers the choice of hemp as a food by employing unsubstantiated scare tactics since 2002.

(2) In developing or reviewing food regulatory measures and variations of food regulatory measures, the Authority must also have regard to the following:

(a) The need for standards to be based on risk analysis using the best available scientific evidence;

Gero Leson is well-respected in international circles for his work on the nutritional benefits of hemp seeds. His specialty is in the food, and technical uses, of agricultural crops such as flax, hemp and coconut. A summary of some of his extensive research is reproduced (with his permission) in Appendix D, "Hemp and Flax Seeds and Oil in Modern Nutrition". It should be noted that his recommendations include that, with hemp's "composition, taste, and culinary diversity" it provides a "promising staple in the growing North American market for 'natural foods'".

A comprehensive analysis of the nutrional profile and benefits of hemp, including comparisons with other foods, is attached as Appendix E ("Hemp Seed Oil", Jace.C. Callaway and David.W. Pate (Finola ky, PL 236, Kuopio, Finland FI-70101, www.finola.com; Departments of Pharmaceutical Chemistry and Neurobiology, University of Kuopio, FI-70211 Kuopio, Finland; 3Centre for Phytochemistry and Pharmacology Southern Cross University, Lismore, NSW 2480 Australia)

(b) The promotion of consistency between domestic and international food standards;

Clearly, the discrepancy between the New Zealand legislation (allowing hemp seed oil to be accepted as a food) and the Australian legislation (prohibiting it) is the glaring example in inconsistency between just two out of the multitude of national and international foods standards. The other inconsistencies are that hemp food is legal to be consumed in the United Kingdom, France, Germany, Switzerland, Hungary, The Netherlands, Japan, China, Canada, the United States and South Africa to name just a few. Some of these nations have been growing hemp for food for thousands of years. Australia is simply following a reactive policy, initiated by the United States, decades ago. The United States has now changed its policy to allow food. We should follow suit. Review of the resolutions and policies of the World Health Organisation and the World Trade Organisation would be desirous.

The National Drug Strategy published by the Federal Government in 2009 continues to foster the scare campaign against hemp. It incorrectly describes the relationship between hemp and cannabis, viz:

"Cannabis is derived from the hemp plant and contains the active substrate tetrahydrocannabinol (THC)."

In fact, hemp and marijuana share the same botanical name, *Cannabis sativa* .

Interestingly, the Drug Strategy does not make a similar error in describing opium and poppy seeds: "Opiates are analgesic drugs derived from the opium poppy. The term 'opioids' includes both opiates (based on naturally occurring compounds) and synthetic compounds that act on opiate receptors."

In addition to the comments above, there is a clear inconsistency in State, Federal and International food standards; Australian farmers can grow hemp but the permissible levels of THC differ between jurisdictions. There is also much education needed for bureaucrats and politicians to get them to understand what their constituents have known for some time.

(c) The desirability of an efficient and internationally competitive food industry

There remains a previous but still uncontested World Trade Organisation (WTO) obligation to liberalise the market as there are no identified public health or safety concerns.

A number of individuals, companies and associations, including the IHAV, have been contacted by Canadian firms who are interested in the Australian market for hemp foods. Our alternative growing season could supply fresh seed for high quality markets in Canada and their further innovation, value adding processes, cultivated varieties and experience could assist the Australian Industry. Currently, this trade is blocked.

For decades, flax seeds and flax seed oils, together with fish oils, have been actively marketed in Australia. It is time that consumers were allowed the same dietary alternatives available in other countries – particularly in view of the dietary imbalances contained in flax and the dangers of mercury in fish and depletion of fish supply for fish oil.

Hemp seeds are the second richest plant source of protein, and are much cheaper to cultivate than soybeans, the richest source. Hemp seed protein could be processed and flavoured any way that soy bean protein can. Hemp products can substitute for milk, ice cream and tofu, for example. Hemp can also be a substitute for wheat in breads, pastries, biscuits, etc., thus providing an alternative for gluten intolerant consumers.

The Canadian hemp industry first exported hemp seed and oil in 2006. Today it is a multimillion dollar industry. 59% of exports are to the United States where hemp food is legal but hemp cultivation is not. Australia has legalised growing of hemp and, in so doing, has a prime opportunity to create new markets, both for export and internally. Approving hemp as a food would unlock trade barriers that currently exist. There are, for example, several major hemp food producers in Canada who are eagerly awaiting the outcome of this FSANZ assessment so they can expand their markets into Australia. Australian farmers would have the opportunity to compete with these overseas suppliers.

Curiously Hemp Seed Oil is currently available in New Zealand and has been successfully imported to Australia, having passed through our rigorous Customs and Quarantine processes.

(d) The promotion of fair trading in food;

As a sustainable and nutritionally beneficial crop, hemp is disadvantaged in Australia as far as trade with the rest of the world is concerned.

(e) Any written policy guidelines formulated by the Council for the purposes of this paragraph and notified to the Authority.

This Association is not aware of any written policy guidelines provided by the Ministerial Council to FSANZ for the purposes of assisting FSANZ in developing food or regulatory measures regarding hemp food. We cannot therefore comment.

3 and 3(A) regarding policy guidelines are beyond the scope of this submission.

(4) Where the Authority considers that the best available scientific evidence referred to in paragraph (2)(a) is insufficient, the Authority may provisionally adopt sanitary or phytosanitary measures on the basis of available pertinent scientific information. In such cases, the Authority must take all reasonable steps to obtain the information necessary for a more objective risk analysis and a review of the sanitary and phytosanitary measures, to be undertaken within a reasonable period of time.

Australia is a member country of the World Trade Organisation and the World Health Organisation. The resolutions and practices adopted by those two organisations should be observed to the fullest extent when undertaking a risk analysis of approving hemp food in Australia.

In its Consultation Paper, FSANZ has demonstrated that it has obtained all the scientific evidence necessary to make a full and complete recommendation to the Ministerial Council. The only issue FSANZ recognised, by its current actions in seeking further consultation, was that there was a lack of scientific evidence to support the 2002 Ministerial decision **not** to allow hemp as a food "because of public perception that it was marijuana". FSANZ has therefore addressed this in its "Questions for submitters". Failing any substantive scientific evidence to support public perception issues, by this section of the FSANZ Act, we believe that FSANZ is bound to undertake its own objective risk analysis. We would hope that the volume and quality of submissions on A1039 made by hemp proponents will not necessitate further review but are happy to assist in the process if necessary.

Objectives of the IHAV include the promotion to consumers and the education of the uses and benefits of hemp. Such promotion has included representation at many expos and sustainability festivals. We have found that people have either completely disassociated hemp from marijuana and are surprised at their relationship or they know exactly the difference, are well informed about THC, and cannot understand why our government continues the prohibition. Many times, at these expos, it has been pointed out to us that hemp is not the only food that contains potentially psychoactive properties. For example mushrooms, chillies, nutmeg and poppies are all foods that have varieties with the potential for mind altering experiences. Also, small amounts of alcohol can be found in fruit juices and other substances such as vanilla essence. Again, it seems unreasonable(even unconscionable) to single out hemp for special treatment.

Australian parliamentarians appear to have blindly adopted the unfounded and unsubstantiated scare tactics employed by anti drug campaigners in the United States. One example of the scare tactics employed in the past were comments on crusades made by H.J. Aslinger, former head of the Federal Narcotics Bureau: "If the hideous monster Frankenstein came face to face with monster marijhuana he would drop dead of fright" (c. 1937). He made these comments assuming his audience to be naïve. Australian consumers are not so naïve. More recent moves in the United States have resulted in legalization of hemp food (6 February 2004). Until then, propaganda about THC content was rife.

QUESTIONS FOR SUBMITTERS

1. Are you aware of any evidence that consumers believe low THC hemp foods have psychoactive effects?

The IHAV has participated in various expos and festivals promoting the uses and benefits of hemp. On display have been products as diverse as wall and floor tiles, baby clothing, home interior textiles, building blocks and food. Display of the latter was compiled using samples that were purchased in supermarkets in the United States and Canada. They were brought into Australia in hand luggage, declared and inspected at Customs on return to Australia and, apart from curiosity interest from Customs staff, no restrictions were made to bringing in the products. These samples included granola (museli) bars, protein powder (used by gymnasiums), a fair trade and hemp coffee blend, hemp flour, hemp oil and toasted and salted hemp seeds.

The IHAV's displays have attracted constant visitation throughout the course of the two or three day expos. None of the thousands of visitors queried marijuana and the vast majority already knew that hemp was not marijuana. Some were even surprised that hemp was, in fact, related to marijuana.

2. Are you aware of any evidence that representations on low THC hemp foods (including labelling and advertising) mislead consumers by leading them to believe that low THC hemp foods have psychoactive effects when consumed?

The Association is not aware of any evidence that consumers have been buying hemp foods to obtain a psychoactive effect from them. Logically, if a consumer wishes to obtain a "high" they must already be aware of the properties of marijuana and will seek out that substance. Parallels can be made with poppy seeds – consumers do not buy poppy seeds for their opiate content. Another parallel is vanilla essence – consumers do not buy vanilla essence for intoxication; they buy mainstream alcohol.

Rather than take a negative stance on the subject of THC, the Ministerial Council should consider that labelling of hemp could follow the guidelines set by labelling of other existing food products. An example is the labelling of wines – completely unrelated to nuts or eggs – which specify on their labelling that the product "may contain traces of nuts or eggs". Packaging for hemp products could be labelled along similar principles – that is, there may have been some other minor traces of a contaminant (THC) because of the processing. However, it should be noted that there have been no known cases of allergic reactions to hemp. This type of labelling would only serve to satisfy the authorities as to the possible traces of THC.

3. Can you provide any evidence in addition to that presented in this Consultation paper whether or not the consumption of low THC hemp foods can return a positive result for a THC drug test?

There is no THC in hemp seeds. THC is found in the leaves of the plant and the bracts of the seed. It is therefore only in the harvesting and processing of the seeds that some minor traces of THC may be found.

Gero Leson and Petra Pless have reviewed the effects (if any) on people who have consumed hemp food products. A copy of their study appears in Appendix F Their conclusion states that "... daily THC doses of 0.45 mg did not cause exceedance (sic) of the 50 parts per billion (ppb) cutoff used by federal [United States] programs to evaluate the outcome of immunoassay screening tests. ... The finding suggest that a conflict between hemp food consumption and workplace drug testing is most unlikely if THC levels in hemp oil and hulled seeds are maintained below 5 and 2 parts per million (ppm) respectively".

The content of THC (if any) in hemp food products is reliant upon State legislation imposing restrictions on the level of THC in the variety of hemp being planted as well as the streamlined harvesting and processing of the seed.

The first country to legislate for consumption of foods that may contain levels of (as opposed to those countries that have used hemp as a food for hundreds of years) was Switzerland. Their regulations have been reported by the North American Industrial Hemp Council and the Nova Institute at http://.naihc.org/hemp_information/content/nova_report/part1.html
which is reproduced at Appendix G. They state, inter alia:

> "The permissible concentration of THC in food depends on two factors: the quantity of THC that can be ingested safely with daily food, and the quantity of food that is consumed daily. Both factors were thoroughly evaluated by nova Institute in the establishment of THC limits.
> "Available scientific evidence suggests that a single dose of 5mg THC and a daily dose of 10mg THC do not cause acute erceptible effects or chronic detrimental effects on health. Using a safety factor of 10, this leads to a pharmacologically innocuous daily intake of 1mg for a healthy adult, correspondint to 0.014 mg of THC per kilogram of body weight."

The content of THC (if any) in hemp food products is reliant upon State legislation imposing restrictions on the level of THC in the variety of hemp being planted as well as the streamlined harvesting and processing of the seed.

4. Can you provide information on THC drug testing procedures in Australia and New Zealand, particularly with regard to regulatory limits of THC that may be set?

The Association recommends that this question be better answered by the National Association of Testing Authorites Australia (NATA). However, please refer to the various overseas studies included in the Appendices. Systems and procedures have been successfully implemented overseas and there is no reason they could not be replicated in Australia.

5. Can you provide information to indicate whether there will be an impact on the cost of testing to THC in humans that could arise from an approval of hemp foods?

The Association recommends that this question be better answered by the National Association of Testing Authorities Australia (NATA). However, it should be noted that, under current legislation for growers of hemp in Victoria, there is already a strict and costly testing regime established under the licensing provisions.

6. **Do you agree that there are adequate controls currently in place, or that would be achieved by imposing maximum limits for THC, to mitigate any risk of high THC *Cannabis* varieties entering the food supply?**

Under current legislation for growers of hemp in Victoria, there is already a strict and costly testing regime established under the licensing provisions. The structure is more than adequate and has, in fact, been relaxed for growers in other States by legislation enacted since the pioneering legislation for Victoria in 1998.

7. **Do you consider that trade practices legislation in Australia and New Zealand is sufficient to mitigate the potential risk that representations (including labelling and advertising) of hemp foods could suggest psychoactive properties relating to consumption of those foods? If not, what other conditions regarding labelling and representations of hemp foods should be considered?**

The trade practices legislation in Australia relating to misleading and deceptive conduct is sufficient to mitigate any risk posed by representations made by retailers or wholesales of hemp foods. There should be no distinction in any trading legislation to hemp foods as opposed to any other food, for example poppy seeds, mushrooms, chillies, nutmeg, cola drinks, fruit juice or any other food that has the potential for a consumers to "over consume".

8. **What is the potential opportunity cost for current producers of hemp crops if hemp foods continue to be prohibited? Please provide quantitative data if available.**

It is difficult to quantify and evaluate the opportunity cost for an untried industry in Australia. There are currently so many legislative impediments to the industry that farmers are reluctant to trial hemp crops on their land.

The responsible authority in Victoria for the issuing of licences is the Department of Primary Industries. Since 1998, the number of growing licences issued has numbered approximately 20. In the past three years, there have been three applications with two having been approved and neither of those licensees are actively growing.

The potential opportunity cost is clear. In 1998, Victoria was the first Australia State to legislate for farmers to grow hemp. The same year, Canada also legislated. Canada's crop value last year was over $500 million. The annual total continues to grow. Victoria (and Australia) has achieved nothing in comparison..

The main reason the industry in Australia has not progressed is that, without food legislation, farmers struggle to find a market for hemp. They struggle because processing infrastructure for uses other than food (e.g. textiles and building products) is cost intensive and investment in this costly infrastructure has not been forthcoming. As with most, if not all, other manufacturing in Australia, off-shore processing is cheaper. However, transportation for hemp is costly, particularly for a new industry (economies of scale would greatly assist).

Processing for food, e.g. cold pressing the seed for oil, already exists for flaxseed, canola, olives, etc. Hemp seeds have a superior nutritional value and, if marketed appropriately, the industry has enormous potential. The oil is an excellent, renewable and sustainable food source to substitute for fish oil – fish are in danger of depletion and pose risks of heavy metal poisoning. Hemp also a substitutes for dairy and wheat products.

It is disappointing that major investment is continuing to be made into finding engineering solutions to our food requirements. A prime example is the joint initiative of the CSIRO, reported recently on ABC radio: "The CSIRO has now teamed up with the Grains Research and Development Corporation and a global seed company in a $50 million deal to take the technology [gene technology to combine the genes of an algae with canola] to the [human food] market."

http://www.abc.net.au/worldtoday/content/2011/s3189117.htm

A further example, reported on 20 April 2011 by the Federal Government sponsored web site, "Get Farming", is that FSANZ has received an application for genetically modified soybean "that is a plant source of omega-3 fatty acids".

Hemp does not require genetic modification to supply omega 3.

These are some aspects of the uses and benefits of hemp that can be marketed to great effect. Farmers are currently missing out on these opportunities because of the prohibition. Reference is again made to the Calloway Pate report in Appendix E.

9. What are the potential benefits to food manufacturers if hemp foods were approved for use?

Food manufacturers would have a new product with which to experiment and diversify – breakfast cereal, bread, ice cream, dairy and soy substitutes of all kinds, to name a few. All products that can be produced from soy can be produced from hemp; many products able to be produced from wheat can be produced from hemp.

White breads have already been proven to be a poor dietary substitute for wholegrain breads. Hemp seeds are gluten free and can be processed into flour for bread and other products. Manufacturers would have a GM free, gluten free, highly nutritional alternative to offer in their products. They have the opportunity to provide a nutritious alternative amongst their product range.

10. Are there likely to be any additional costs for food manufacturers wishing to supply hemp foods

No. Processing plants already exist for cold pressing oils for food and for milling protein powders and flours. The hemp seeds they process would already have satisfied the strict licensing regime in place for primary producers and thus no THC testing would be warranted.

If manufacturers were to choose further product development, such as has occurred in Canada, further infrastructure costs may be incurred. This does not differ from progress achieved in any other manufacturing sector. Some processing methodology is explained in Appendix E (Callaway and Pate).

11. Would the approval of low THC hemp foods increase the cost of food enforcement beyond what would be expected of the approval of any other substance added to food, or other food regulatory change?

Whilst current enforcement costs have not been quantified in the Consultation Paper, it is difficult to see how the cost of any enforcement would be increased with the regulatory structures already in place for testing THC in areas under crop. Under current licensing legislation, it is the farmers who bear the regulatory costs. In addition, there must already be in place enforcement for testing of other agricultural products which have similar risks of "contamination" of drug-like substances in crops, such as chillies, nutmeg, mushrooms and poppies.

12. What other legislation in Australia and New Zealand would affect or be affected by approval of hemp foods?

If approved as a food, hemp would need to be excluded from the relevant State and Federal laws that specify it as a prohibited substance.

The most logical way to achieve this is by altering the definition of "*Cannabis sativa*" to limit it to varieties of *Cannabis sativa* with more than (x) percentage level of THC.

13. Would the approval of hemp food have an impact on existing hemp regulations in Australia and New Zealand? For example, would industrial hemp destined for use in food require additional controls to those already specified in industrial hemp regulations?

No. Hemp food is derived from the seed (technically a nut) of the *Cannabis sativa* plant. The seed contains no THC whatsoever – regardless of how much THC the plant variety itself contains. Hemp producers' regulations already control the level of THC in food.

14. Would food manufacturers be required to be licensed under existing hemp regulations?

No. Food manufacturers, as with any other users, would be prohibited from selling a prohibited substance. Under our submission in (12) above, the same laws would apply under any future illegal possession, etc. as apply now with the qualification of THC level (i.e. low THC would not be prohibited and therefore not illegal to sell or possess). Licensing would add an unnecessary cost impost and simply be yet another layer of bureaucracy.

15. Would additional costs be incurred by government agencies responsible for granting licences for the cultivation of hemp as a result of approval of hemp foods?

Government agencies are currently structured under self-finding arrangements. In Victoria, farmers are required to pay sampling fees of $616 a minimum of three times each during the three month cropping season – an unreasonable cost impost, given that the seed itself needs certification as being a low THC variety before a licence can be granted. These fees are struck so that the relevant government agency does not lose. Thus far, staff at DPI are a current cost because they are assessing applications with protracted approval processes and ongoing salary costs without the successful applicants progressing to sowing, harvesting and marketing.

16. Can you identify other risk management options that have not been considered in the impact analysis? Comments on the possible costs and benefits are welcome.

Currently, all cost and risk in Victoria rests with the farmers. The IHAV has been approached on many occasions by land holders who have a knowledge of, and desire to grow, hemp. The risk management options for FSANZ are similar to those in the enforcement of any other food standard. The same principles would apply to poppy seeds, fruit juice, nutmeg, mushrooms, chillies, etc. – all of which have varieties that are potentially harmful to human health. The benefits for farmers and others in the supply chain, as well as the community as a whole, include:

1. Significant agricultural pesticide use reduction – cotton uses more chemicals per unit of crop than all other crops in Australian agriculture;
2. Soil redemption by replacing depleted soil nitrogen and improving organic composition;
3. Forest conservation – hemp can be used as an alternative to many timber products, including paper;
4. Landfill use reduction because of biodegradability;
5. Water retention and better water management
6. Improved yields of other crops through crop rotation with hemp crops
7. Minimal fertiliser use, particularly compared with cotton
8. Positive impact on weed control

17. Can you identify any other costs and benefits for any of the risk management options considered in this paper?

The not-for-profit IHAV does not have the financial capacity to carry out economic feasibilities. However, the Federal Government, through its CSIRO, has already identified a critical need for an alternative, viable source of omega 3.

The CSIRO is currently researching a genetically engineered plant-based omega 3. They are using algae (from which deep sea fish feed and obtain their omega 3 nutrients) with canola. The project has a startup budget of $50 million. That budget could more reasonably be applied to far more worthwhile causes. Approving hemp for food would open new markets for farmers and provide a non-genetically modified, predominantly (if not entirely) organic and sustainable omega 3 food source.

Genetically modified soy bean to produce omega-3 is the subject of a current application to FSANZ (application A 1041). Hemp does not require genetic modification to supply omega-3.

18. Do you have a view about an appropriate preferred regulatory option regarding the approval of hemp foods, based on benefits and costs?

Bringing the State regulations for growing hemp into line with each other would allow better market competition between States, In addition, re-defining the description of *Cannabis sativa* in various poisons and controlled substances legislation would provide clarity and streamlining. We recommend that, where prohibition of *Cannabis sativa* applies, the definition be limited to *Cannabis sativa* contain more than 1% of THC.

Conclusion

The IHAV was established to give a voice to the hemp industry and this submission focuses on the uses and benefits of hemp, as opposed to any perceived relationship or association with marijuana. Just as it is legal to sell poppy seeds for human consumption in Australia (with minimal traces of opiates), it should also be legal to consume hemp seeds and hemp seed products (with minimal traces of tetrahydrocannabinol (THC)).

IHAV members believe Australians should have the same food choices that exist in every other country.

FSANZ has already spent significant time and resources on assessing hemp food and has found no scientific basis to reject it. Politics should be set aside in the interests of public health.

"The easiest way to consider the implication of hemp and agriculture on our society is to remember, anything produced from hydro-carbon (fossil fuels) can also be produced from carbohydrates (plant matter)". ("Practical Guide to Hemp", HempLobby.org).

Rather than spend more time and money trying to prove that hemp is unsuitable for human consumption, the resources should be spent improving the infrastructure and viability of hemp processes.

The Industrial Hemp Association supports the application for approval of low THC *Cannabis sativa* (hemp) as a food.

APPENDIX A

APPENDIX B

APPENDIX C

APPENDIX D

APPENDIX E

APPENDIX F

APPENDIX G

17 Codes of practice

Codes of practice, and variations of codes of practice, may deal only with matters that may be included in standards.

18 Objectives of the Authority in developing or reviewing food regulatory measures and variations of food regulatory measures

(1) The objectives (in descending priority order) of the Authority in developing or reviewing food regulatory measures and variations of food regulatory measures are:

(a) the protection of public health and safety; and

(b) the provision of adequate information relating to food to enable consumers to make informed choices; and

(c) the prevention of misleading or deceptive conduct.

(2) In developing or reviewing food regulatory measures and variations of food regulatory measures, the Authority must also have regard to the following:

(a) the need for standards to be based on risk analysis using the best available scientific evidence;

(b) the promotion of consistency between domestic and international food standards;

(c) the desirability of an efficient and internationally competitive food industry;

(d) the promotion of fair trading in food;

(e) any written policy guidelines formulated by the Council for the purposes of this paragraph and notified to the Authority.

(3) If any policy guidelines formulated by the Council for the purposes of paragraph (2)(e) are notified to the Authority, the Authority must publish the guidelines on the Authority's website.

(3A) Policy guidelines formulated by the Council for the purposes of paragraph (2)(e) must not be inconsistent with the objectives set out in subsection (1).

(4) Where the Authority considers that the best available scientific evidence referred to in paragraph (2)(a) is insufficient, the Authority may provisionally adopt sanitary or phytosanitary measures on the basis of available pertinent scientific information.

In such cases, the Authority must take all reasonable steps to obtain the information necessary for a more objective risk analysis and a review of the sanitary or phytosanitary measures, to be undertaken within a reasonable period of time.

(5) For the purposes of this section, a ***sanitary or phytosanitary measure*** means any measure applied:

(a) to protect animal or plant life or health from risks arising from the entry, establishment or spread of pests, diseases, disease-carrying organisms or disease-causing organisms; or

(b) to protect human or animal life or health from risks arising from additives, contaminants, toxins or disease-causing organisms in foods, beverages or feedstuffs; or

(c) to protect human life or health from risks arising from diseases carried by animals, plants or products thereof, or from the entry, establishment or spread of pests; or

(d) to prevent or limit other damage from the entry, establishment or spread of pests;

and includes:

(e) any relevant law, decree, regulation, requirement or procedure, including end product criteria; and

(f) processes and production methods; and

(g) testing, inspection, certification and approval procedures; and

(h) quarantine treatments including relevant requirements associated with the transport of animals or plants, or with the materials necessary for their survival during transport; and

(i) provisions on relevant statistical methods, sampling procedures and methods of risk assessment; and

(j) packaging and labelling requirements directly related to food safety.

(6) A policy guideline formulated by the Council for the purposes of paragraph (2)(e) is not a legislative instrument.

19 Notices to be given to the Gene Technology Regulator

If a provision of this Act requires the Authority to give a notice concerning an existing or proposed food regulatory measure to the Gene Technology Regulator, the Authority is only required to give the notice if the food regulatory measure relates to food that is or contains a GMO or a GM product.

The Nutritional Benefits of Hemp

NUTRITIOUS HEMP OIL IS EMERGING AS ALTERNATIVE TO TOXIN-TAINTED FISH

New Study Finds Mercury Pollution Is a Serious Health Risk for Those That Eat Fish

Sebastopol, CA– Although consumption of fish is widely touted by medical and nutrition experts as good for the heart and overall health, in large part due to its content of essential fatty acids, more and more medical studies are raising concerns due to toxic levels of mercury in fish. Both USA Today and the San Francisco Chronicle featured this in November 2002 articles that highlighted yet another scientific study warning of the dangers of mercury in fish. The good news is that there is a healthy alternative to provide the essential fatty acids and other key nutrients recommended by leading medical experts that is becoming widely available in the U.S.: Organic Hemp Oil.

The recent fish mercury study, published in Environmental Health Perspectives, demonstrates the occurrence of dangerous human mercury blood concentrations associated with fish consumption. "We found that if people eat fish, the mercury (level in their blood) goes up. They stop eating the fish, the mercury goes down," said the author of the study, Dr. Jane Hightower, a doctor of internal medicine at California Pacific Medical Center in San Francisco. The subjects of the study were eating a diet high in canned tuna, salmon, swordfish, sea bass, halibut and tuna steaks. A CNN article recently reported that some fish, such as "farm-raised" fish, often contain significantly higher levels of toxins than wild fish.

Mercury pollution is an emerging environment and health problem caused by many man-made sources including coal-burning power plants and waste incinerator emissions. Mercury accumulates in the food chain, with large fish typically containing the highest amounts. Mercury can harm the human brain and the entire nervous system, contributing to behavioral problems and impairments of the immune and reproductive systems and cardiovascular disease. Federal agencies have been warning pregnant women to reduce ingestion of fish due to the potential for toxic contamination that may impair development of the baby's brain functions. With the federal government blocking regulations to reduce toxic emissions from power plants, this health crisis will only increase in importance to Americans.

The study results have created a serious dilemma for medical experts that have supported fish consumption as a key component of a healthy diet. The findings highlight the need for toxin-free alternative foods that can substitute for the nutrient profile of fish. Organic hemp oil is a clean and healthy fish alternative for consumers concerned about the high level of mercury and other toxic contaminants in fish. Hemp oil's essential fatty acid profile is closer to fish oil than any other vegetable oil.

WHY "EFAS" FOUND IN HEMP & FISH ARE SO IMPORTANT FOR THE MODERN DIET

Essential fatty acids (EFAs) are components of fat that humans need to be healthy, however, our bodies can't produce them and therefore they must be obtained through the diet. EFAs come in 2 families, called omega-6 and omega-3. Medical professionals including the renowned Dr. Andrew Weil recommend hemp oil due to its ideal omega-6 to omega-3 EFA ratio. In the respected book Fats that Heal, Fats that Kill, nutrition expert Udo Erasmus states, "The best-balanced plant source of EFA's is hemp seed oil." While health officials with the World Health Organization, Canada, Japan and Sweden recommend a 4:1 ratio, hemp oil's 3:1 ratio is the closest of any naturally occurring oil.

It is estimated that 90% of Americans do not consume enough omega-3, known as the omega-3 EFA. Hemp oil is also the source of a rare super omega-3 EFA called stearidonic acid (SDA) that is the "first metabolite" in the omega-3 family and therefore easy for the body to process. Omega-6 EFAs are frequently added to foods through the use of common vegetable oils like corn, sunflower, and safflower, however, many people are unable to properly utilize omega-6 oils because enzymes needed to metabolize these oils are hampered by stress, environmental toxicity or aging. Hemp oil is a unique plant source of the rare and valuable super omega-6 EFA called gamma-linolenic acid (GLA) that is easy for the body to process and it bypasses the enzymatic blocks to allow proper omega-6 utilization. GLA is the key regulator of T-lymphocyte functions in the immune system and is involved in cell metabolism and growth.

Certificate of Analysis

Product Name: <u>**Hemp Seed Oil Refined**</u>

Plant Source *Cannabis sativa*

Batch Number: HMP801B-RBD

Quantity: 20 litres (20 x 1 litre)

DOM: 14th December 2009

Expiry Date: 14th December 2010

OIL SEED EXTRACTIONS

Description:
This Cold Pressed Refined Hemp seed oil has been extracted from the seeds of the Hemp plant (*Cannabis sativa*), which has been grown without the use of agri-chemicals. It has been extracted using an expeller type press and contains no solvent residues. This oil has been produced in a GMO/GE free production process, and contains no THC.

Test	Result	Limit
Appearance	Pass	A clear yellow oil
Acid Value	0.12 mg KOH/g	NMT 4.0 mg KOH/g
Peroxide Value	0.3 meq/kg	NMT 10.0 meq/kg
<u>Fatty Acid Composition</u>		
C16:0 Palmitic	5.9%	4.0 – 10.0%
C18:0 Stearic	2.4%	1.0 – 4.0%
C18:1 Oleic	9.4%	6.0 – 20.0%
C18:2 Linoleic	53.5%	45.0 – 65.0%
C18:3 α-Linolenic	20.9%	14.0 – 28.0%
C18:3 γ-Linolenic	1.6%	1.0 – 5.0%
<u>Others</u>	1.6%	0.0 – 4.0%
<u>Micro-Biological</u>		
TPC (cfu/g)	<50	<1000
Confirmed Coliform Count (per g)	Not detected	Not detected
E.coli Count (per g)	Not detected	Not detected
Yeast & Mould Count (cfu/g)	<50	<100
Salmonella Isolation (per 25g)	Not detected	Not detected

Packaging: This product is packaged as per customer requirements, and purged with nitrogen.

Storage: This product should be stored in a cool and dry place, protected from light.

Shelf Life: If stored in unopened containers at less than 20 Deg Celcius, this product can expect to have a shelf life of 12 months.

Quality approved: Date: 14th December 2009

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Evaluating Interference of THC in Hemp Food Products With Employee Drug Testing

Study Summary

Prepared by

Gero Leson, D.Env. and Petra Pless

Leson Environmental Consulting, Berkeley, California

July 2000

Executive Summary

A toxicological study was conducted to evaluate the potential conflict between extended consumption of hemp food products and workplace drug-testing programs in the United States. Fifteen volunteers ingested hemp/canola oil blends containing four different concentrations of delta-9-tetrahydrocannabinol (THC), each over a 10-day period. Corresponding THC doses ranged from 0.09 to 0.6 milligrams per day. Two urine samples were collected at the end of each period and analyzed for THC metabolites by immunoassay and GC/MS (gas chromatography/mass spectroscopy). Samples were also collected prior to the test and on days 1 and 3 after the last oil had been ingested.

The analyses showed that daily THC doses of 0.45 mg did not cause exceedance of the 50 parts per billion (ppb) cutoff used by federal programs to evaluate the outcome of immunoassay screening tests. Confirmation of these samples by GC/MS consistently found THCCOOH levels less than 5 ppb, with the exception of one sample confirmed at 5.2 ppb. This is significantly below the 15 ppb cutoff for confirmation under federal programs. THC doses as low as 0.2 mg/day caused several exceedances of the more stringent 20 ppb screening cutoff used by few employers and law enforcement agencies. Yet all of these samples were confirmed at less than 5 ppb. One of three volunteers consuming up to 0.6 mg/day of THC screened positive at the 50 ppb level but was confirmed at less than 5 ppb.

The findings suggest that a conflict between hemp food consumption and workplace drug testing is most unlikely if THC levels in hemp oil and hulled seeds are maintained below 5 and 2 parts per million (ppm) respectively, and if drug testing programs follow federal guidelines requiring that any urine sample screening positive be confirmed by GC/MS.

Background

In recent years, food products made from or containing seeds of the hemp plant (*Cannabis sativa*) have increasingly become available in natural food stores in North America. Hemp seeds offer several nutritional benefits. These include a balanced fatty acid composition of the oil (desirable omega-3/omega 6 ratio and presence of minor fatty acids such as gamma-linolenic acid (GLA)), a reasonably complete amino acid spectrum of the seed meat, and comparatively high concentrations of vitamin E. Food items from hemp seeds include cold-pressed oil used for cooking, in dressings, and in capsules as supplements. Hemp oil is also used in a range of bodycare products, such as creams, shampoos, soaps, and lip balms. The seeds are generally hulled prior to use in snack bars, nut butters, and other spreads, or sold in bulk for cooking and baking. A small amount of whole seeds continues to be used in snacks. Since commercial hemp farming was relegalized in Canada in 1998, the majority of hempseeds and oil in the U.S., previously made from imported Chinese birdseed, now originates in Canada and in the European Union (EU). Commercial farming of hemp in the U.S. remains prohibited under federal law.

The expansion of products from hemp seeds into their largest potential North American market, the "natural foods" sector in the U.S., now faces a significant obstacle. Flowers of industrial hemp plants contain minute quantities of delta-9-tetrahydrocannabinol (THC), the main psychoactive ingredient in marijuana. Industrial hemp varieties grown in Canada and the EU are bred to contain less than 0.3% THC in the upper portion of the flowering plant. In comparison, marijuana plants may contain 2-20% THC.

Depending on the hemp variety and the degree of seed cleaning, various amounts of THC residues can be found on the outer shells of whole seeds and in the products made from hemp seeds. The presence of THC in hemp foods has raised concern over their potential interference with employee drug-testing programs in the U.S. Studies conducted in 1995—1997 showed that eating hemp foods may in fact cause positive urine tests for marijuana. However, these studies involved the consumption of products from seeds with considerably higher THC levels–often more than 100 micrograms per gram (µg/g) or parts per million (ppm)–than are now commonly found in commercial hemp seeds in North America. Thus, these studies do not allow a realistic assessment of the potential impact of such foods on the outcome of employee drug tests. However, the federal Drug Enforcement Agency (DEA) and the Office of National Drug Control Policy cite the potential interference with drug-testing programs as one of their main objections to the importation and sale of hemp foods in the U.S.

Thorough cleaning of hemp seeds typically keeps THC levels in oil and hulled seeds produced in Canada to less than 5 and 2 ppm, respectively. Regulations in Canada, the main supplier of hemp seeds to the U.S., limit THC levels in hemp seed products to 10 parts per million (ppm). In the U.S., there is currently no such standard for the concentration of THC in food items.

- Typical workplace drug testing procedures for marijuana in the U.S.

A urine sample–announced or random–is collected and screened for THC metabolites, using an immunoassay test. Such immunoassays can be performed rapidly and at low cost, yet they are not highly specific for THCCOOH, the main metabolite of THC. If a screening test detects THCCOOH above a specified "cutoff" concentration–federal workplace testing programs apply a 50 nanograms/milliliter (ng/mL) or parts per billion (ppb) cutoff–the sample is then "confirmed" by the more specific GC/MS (gas chromatography/mass spectroscopy) method. If GC/MS detects THCCOOH at levels above the confirmation cutoff of 15 ppb, a urine sample is considered "confirmed positive" for marijuana. Some employers and law enforcement agencies in the U.S. use a lower screening cutoff of 20 ppb and confirmation cutoff of 10 ppb. Very few drug-testing programs rely solely on the positive outcome of a screening test without automatic subsequent confirmation testing by GC/MS.

Study Objective and Design

The objective of the present study was to reevaluate the potential impact of hemp food consumption on the outcome of workplace drug tests for marijuana. Specifically, the study was designed to establish a correlation between extended daily ingestion of THC via hemp food and the likelihood of failing screening or confirmation tests of urine samples. The study involved 15 adult THC-naïve volunteers (ages 29—84, 10 female, 5 male). Each volunteer ingested, during four consecutive 10-day periods, daily THC doses ranging from 0.09 to 0.6 milligrams (mg), much below the typical 10 mg threshold for psychoactivity from THC ingestion.

THC was consumed in 15 milliliter (mL) doses–equivalent to one tablespoon (0.6 mg in 20 mL)–of four different blends of hemp and canola oils. The table shows the daily THC doses administered during the study and the corresponding amounts of hemp oil and hulled seeds–containing 5 and 2 ppm THC, respectively–that would have to be eaten to ingest the same amounts of THC.

Urine samples were collected prior to the first ingestion of oil (baseline sample), on days 9 and 10 of each of the four study periods, and 1 and 3 days after the last ingestion. All samples were analyzed for cannabinoids by radioimmunoassay (RIA), confirmed for THCCOOH by gas chromatography-mass spectrometry (GC/MS), and analyzed for creatinine to identify dilute samples.

THC concentration in oil, daily doses, and corresponding oil and seed consumption

Study period (10 days each)	Oil dose	THC dose	Corresponds to daily consumption of		
			Hulled hemp seeds	Hemp seed oil	
#	(mL/day)	(mg/day)	(g/day) at 2 µg/g THC	(mL/day) at 5 µg/g THC	(mL/day) at 20 µg/g THC
1	15	0.09	45	19	5
2	15	0.19	95	40	10
3	15	0.29	150	63	16
4	15	0.45	225	95	24
4	20	0.60	300	126	32

Findings and Conclusions

Analysis of the collected urine samples showed that even extended ingestion of up to 0.45 mg/day of THC is not likely to cause interference with federal drug-testing programs. The table shows that this daily dose of THC translates into the daily eating of 6 tablespoons of hemp oil or half a pound of hulled hemp seeds of commercial quality. Even hemp food connoisseurs rarely consume such quantities. At this dose, none of the volunteers exceeded the 50 parts per billion (ppb) cutoff for the immunoassay screening test, applied by federal workplace drug-testing programs. Confirmation by GC/MS consistently found THCCOOH levels of less than 5 ppb–i.e., considerably below the 15 ppb confirmation cutoff. The highest THCCOOH level measured in a single sample was 5.2 ppb.

THC doses as low as 0.2 mg/day caused several exceedances of the lower, more stringent, 20 ppb screening cutoff used by few employers and law enforcement agencies. Yet GC/MS confirmation found less than 5 ppb of THCCOOH in all of these samples. One of three volunteers consuming up to 0.6 mg/day of THC screened positive at the 50 ppb level, but was also confirmed at less than 5 ppb.

These findings suggest that even extended ingestion of considerable quantities of currently available hemp foods is not likely to produce urine samples that exceed the 50 ppb cutoff in the immunoassay screening test and a 10 or 15 ppb confirmation cutoff. The occurrence of screening positives at the 20 ppb cutoff is conceivable. However, their confirmation by GC/MS at the 10 or even 15 ppb cutoff is even less likely. Thus programs following the federal testing guidelines are unlikely to encounter confirmed positive samples for marijuana. On the other hand, programs that rely entirely on the use of screening tests with a low cutoff of 20 ppb and no automatic confirmation of screening positives by GC/MS may occasionally encounter unconfirmed positive samples from consumers of hemp foods.

In summary, this study's findings indicate that the following measures will be effective in virtually eliminating interference between consumption of hemp food products and workplace drug testing:

- Adherence by hemp food processors to seed cleaning and quality control measures aimed at limiting concentrations of total THC in hemp oil to 5 μg/g–or ppm–and, in hulled seeds, to 2 μg/g.
- Adherence of U.S. employers and administrators of drug-testing programs to guidelines for federal programs, requiring that urine samples that fail a screening test be confirmed by GC/MS.

A detailed description of the study's design and results is being submitted for publication in a peer-reviewed journal. It will be posted at www.naihc.org following its publication.

Acknowledgments

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Finally, the authors wish to express their particular gratitude to the volunteers, whose reliable observation and documentation of the prescribed oil consumption and urine sampling regimen were essential to the data quality of this study.

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6

Hempseed Oil

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Introduction

Nondrug varieties of *Cannabis sativa* L., collectively known as "hemp," provide an important source of industrial fiber. Hemp fiber is used in the production of specialty paper (e.g., cigarette papers, bank notes, and tea bags), in addition to ropes, woven and nonwoven fabrics, automotive and building insulation, construction materials, and many other durable goods. Fiber varieties of hemp can be over four meters tall, and require over 150 days for seed maturation. In contrast, oilseed varieties are usually less than two meters tall at the time of harvest (110 to 150 days after sowing), which allows them to be efficiently harvested by conventional grain combines. Hemp contains very low amounts of δ-9-tetrahydrocannabinol (THC), the main psychoactive component in drug varieties of *Cannabis*. The amount of THC in the mature hemp plant is typically less than 0.5% of the plant's dry weight, which is not sufficient for drug purposes. In addition, THC is not a toxic compound in humans, even at high dosages and over long periods of time.

Hempseed oil is a highly unsaturated product that is pressed or extracted from the achenes of *Cannabis*, which are also a source of highly digestible protein (Table 6.1); thus, the tiny nut is an exceptionally good source of nutrition (Callaway, 2004; Deferne & Pate, 1996). This fruit of *Cannabis*, which has a relatively hard shell when mature, varies in shape—from almost spherical to somewhat oblong. Its overall size can vary considerably, but most often it approximates a match-head.

Not only does food-quality hempseed oil taste and smell delicious, it is extremely rich in lipid nutrients. The chemical analysis of hemp and other major seed oils was well underway in the late nineteenth century (Von Hazura, 1887) when linoleic acid (LA) was first identified (as "sativinsäure" or "sativic acid") as the main component of hempseed oil. The quantitative analysis of the major fatty-acid components in hempseed oil became of scientific interest in the early twentieth century (Kaufmann & Juschkewitsch, 1930). The essential fatty acids (EFAs) are well represented in hempseed oil. The "ω-6" LA (18:2n-6) component is present at about 55%, and

Table 6.1. Typical Nutritional Composition of Whole Hempseed, Dehulled Seed, and Seed Meal* (modified from Callaway, 2004)

	Whole seed	Dehulled seed	Seed meal
Oil	36%	44%	11%
Protein	25	33	34
Carbohydrates	28	12	43
Moisture	6	5	5
Ash	5	6	7
Energy	2200	2093	1700
Total dietary fiber	28%	7%	43%
Digestible fiber	6	6	16
Nondigestible fiber	22	1	27

*cultivar Finola

"ω-3" α-linolenic acid (ALA, 18:3n-3) occurs at about 20%. In addition, significant amounts of their respective metabolic products are found: the presence of γ-linolenic acid (GLA, 18:3n-6) ranges from 1 to 4%, and stearidonic acid (SDA, 18:4n-3) occurs at about 0.5 to 2%. While most vegetable oils have at least some EFAs, to have such high amounts of both is unusual, and in this proportion, in addition to GLA and SDA (Table 6.2). In fact, no other industrial crop can make this claim.

No great differences exist in the amounts or proportions of EFAs between an oilseed hemp cultivar from Northern Europe and a typical fiber hemp cultivar from Central Europe (Table 6.2). However, a considerable difference in the native abundance of both GLA and SDA was noted between northern and southern varieties of hempseed within the first report on the presence of SDA in hempseed (Callaway et al., 1997). Subsequent investigations confirmed this observation (Anwar et al., 2006; Bagci et al., 2003; Blade et al., 2005; Callaway, 2002, 2004; Matthäus et al., 2005; Mölleken & Theimer, 1997). The highest concentrations of GLA and SDA are found in the seeds of hemp varieties that are derived from extreme northern climes (Blade et al.. 2005; Callaway et al., 1997). Perhaps their higher amounts of super-unsaturated fatty acids protect these seeds from freezing solid during the harsh winter months, conferring the evolutionary advantage of an expanded range. Hempseed oil, for example, does not begin to thicken until it is stored for at least several days below –20°C. In an early study (Ross et al., 1996) on the fatty-acid profile of seed oils from drug-*Cannabis*, a remarkable uniformity was found in profiles of confiscated samples from Mexico, Columbia, Jamaica, and Thailand. These tropical seed samples were missing (ALA, which complements the aforementioned observations of greater seed-oil unsaturation being correlated with more extreme latitudes.

If the nuisance of shell fragments between the teeth is disregarded, one can consume whole hempseed directly from the plant, because it lacks the anti-nutritive

Table 6.2. Typical Fatty-Acid Profiles (%) of Hemp and Other Seed Oils (Callaway, 2004)

Seed	Palmitic acid	Stearic acid	Oleic acid	LA	ALA	GLA	SDA	%PUFA	n-6/n-3 ratio
Oil hempseed*	5	2	9	56	22	4	2	84	2.5
Fiber hempseed	8	3	11	55	21	1	<1	77	2.7
Black currant	7	1	11	48	13	17	3	81	4.1
Flax (linseed)	6	3	15	15	61	0	0	76	0.2
Evening primrose	6	1	8	76	0	9	0	85	>100.0
Sunflower	5	11	22	63	<1	0	0	63	>100.0
Wheat germ	3	17	24	46	5	5	<1	56	10.2
Rapeseed	4	<1	60	23	13	0	0	36	1.8
Soy	10	4	23	55	8	0	0	63	6.9
Borage	12	5	17	42	0	24	0	66	>100.0
Corn	12	2	25	60	1	0	0	60	60.0
Olive	15	0	76	8	<1	0	0	8	>100.0

*cultivar Finola. LA = Linoleic Acid (18:2n-6), ALA = α-Linolenic Acid (18:3n-3), GLA = γ-Linolenic Acid (18:4n-6), SDA = Stearidonic Acid (18:4n-3), PUFA = Polyunsaturated Fatty Acid, n-6/n-3 Ratio = Percentages of ω-6 Fatty Acids Divided by ω-3 Fatty Acids
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properties that are commonly found in so many other raw foods and oilseeds (Mattäus, 1997). One can also feed the seed-press meal to pets and livestock. Hempseed also does not contain gluten, which makes it an important source of vegetable protein for people who suffer from coeliac disease (also written as "celiac" disease), an autoimmune-based gluten intolerance disorder of the small bowel that affects approximately 1% of Indo–European populations, and a disease which is significantly underdiagnosed (Collin, 1999). In addition to its value for oil and protein, hempseed and the seed meal by-product of oil pressing also contain respectable amounts of vitamins and minerals (Table 6.3).

The use of *Cannabis* as a source of food, fiber, and medicine is widespread in the Old World, and the whole seed continues to be used as a food and condiment by people in Asia (Xiaozhai & Clarke, 1995). After considering the historical accounts that demonstrate an intimate human relationship with this plant, imagining that this seed was overlooked by ancient humans in its transition from food gathering to the development of agriculture is difficult (Weiss et al., 2004). The oldest existing documents that describe the use of hempseed as both food and medicine are from China (de Padua et al., 1999), where *Cannabis* stalks, leaves, and seeds were found in tombs that are over 4500 years old (Jiang et al., 2006). Good evidence suggests that

Table 6.3. Typical Nutritional Values for Vitamins and Minerals in Hempseed* (Callaway, 2004)

Vitamins and minerals	Nutritional values
Vitamin E (total)	90 mg/100 g
α-tocopherol	5 mg/100 g
γ-tocopherol	85 mg/100 g
Thiamine (B1)	0.4 mg/100 g
Riboflavin (B2)	0.1 mg/100 g
Phophorus (P)	1,160 mg/100 g
Potassium (K)	859 mg/100 g
Magnesium (Mg)	483 mg/100 g
Calcium (Ca)	145 mg/100 g
Iron (Fe)	14 mg/100 g
Sodium (Na)	12 mg/100 g
Manganese (Mn)	7 mg/100 g
Zinc (Zn)	7 mg/100 g
Copper (Cu)	2 mg/100 g

*cultivar Finola

Cannabis was used as a source of fiber and as a medicament in Ancient Egypt (Russo, 2007). Other tangible evidence suggests that *Cannabis* was used as a source of fiber for at least 6000 years (Schultes, 1970), and possibly up to 12,000 years (Abel, 1980). Patterns of woven material, possibly *Cannabis* fibers in the form of nets for trapping small animals, were preserved as fossilized remains that are over 20,000 years old (Pringle, 1997). By providing a nutritious food from its seed, a durable fiber from its stalk, and an efficacious medicine from its flower and leaves, *Cannabis* has assisted in human development like no other plant species. A more intimate relationship for the co-evolution of *Cannabis* with humans was advanced (McPartland & Guy, 2004).

Hempseed Oil Composition

Good-quality, cold-pressed hempseed oil has a clear green to olive color, and ideally possesses a fresh nutty taste and smell (Table 6.4). It is an exceptionally rich source of polyunsaturated fatty acids (PUFAs), ranging from 75 to 85% (Table 6.2) of the total oil content (Blade et al., 2005; Callaway et al., 1997; Kriese et al., 2004; Matthäus et al., 2005). The absolute amounts of GLA and SDA in hempseed oil seem to be genetically determined, and their relative ratio is highly consistent, showing a range from 0.67 to4.08% and 0.4 to1.6%, respectively, of the total seed oil (Matthäus et al., 2005).

The ratio of n-6/n-3 EFAs in hempseed oil (i.e., the percentages of LA divided by ALA) is typically near an ideal value for their efficient and simultaneous metabolic conversion. Due to the metabolic competition between the two EFAs for access to the rate-limiting enzyme δ-6 desaturase (Gerster, 1988), the significance of an appropriate dietary ratio of these fatty acids is important to consider in any discussion of general health (Okuyama et al., 1997) and within the interpretation of results from clinical studies that contain significant amounts of these oils (Simopoulos, 1999), especially in chronic-disease states. Only a decade ago, an optimal LA to ALA (n-6/n-3) ratio was considered to be somewhere between 5:1 and 10:1 (WHO & FAO, 1995). Soybean oil was popular and promoted as a healthy oil by the food industry and the agricultural community at the time, apparently because its ratio (about 7:1) is within that range. More recent considerations suggest an optimal n-6/n-3 ratio to be somewhere between 2:1 and 3:1 (Simopoulos et al., 2000), which reflects the ratio found in the traditional Japanese and Mediterranean diets, where the incidence of coronary heart disease was historically low. Fortuitously, the n-6/n-3 ratio in most commercial hempseed oils is typically near 2.5:1 (Table 6.2; Callaway et al., 1997; Kriese et al., 2004).

Flaxseed (*Linum usitatissimum*) oil typically contains about 60% of ALA, but lacks both GLA and SDA, while hempseed oils tend to have just over 20% of ALA (Table 6-B). An excess of ALA can disturb the human metabolic balance of fatty-acid metabolism by leaving a net deficit in "ω-6" metabolites, which are derived from dietary LA. In fact, the daily use of only two tablespoons of flaxseed oil per day can sig-

Table 6.4. Technical Characteristics of Cold-pressed Hempseed Oil

Solidification point	–20°C
Flash point	141°C
Smoke point	165°C
Specific gravity	0.9295 g/mL at 20°C
Saponification value	193
Iodine value	160
Chlorophyll content	5–80 ppm
Color:	
fresh cold-pressed oil	clear bright to dark green; fresh, nutty smell
old cold-pressed oil	clear olive green to yellow; fishy, paint smell
refined oil	clear colorless to light yellow; odorless to paint smell
Peroxide value:	
food-grade	< 2 meq/kg
cosmetic-grade	<10 meq/kg
industrial-grade	>10 meq/kg
Free fatty acid value:	
food-grade	<0.1%
other grades	>1.0%

nificantly decrease the competitive metabolic production of GLA from LA (Schwab et al., 2006). The presence of both GLA and SDA in hempseed oil allows this competition for δ-6-desaturase to be efficiently bypassed (Callaway et al., 2005; Okuyama et al., 1997; Schwab et al., 2006), while the favorable n-6/n-3 ratio in hempseed oil allows for the efficient metabolism of both EFAs to proceed in concert.

Protein By-products of Hempseed

Hempseed and hempseed meal are excellent sources of digestible protein. Figure 6.1 compares the amino acid profile for the total protein in hempseed, soy bean and egg white. Protein concentrations vary between whole hempseed (ca. 25%), de-hulled hempseed (ca. 45%) soy bean (ca. 32%) and egg white (ca. 11%). Figure 6.1 illustrates individual amino acid values per 100 g of protein to provide a direct comparison between these products. Another important fact to keep in mind is that hempseed and egg white lack the anti-nutritional trypsin-inhibiting factors that are found in

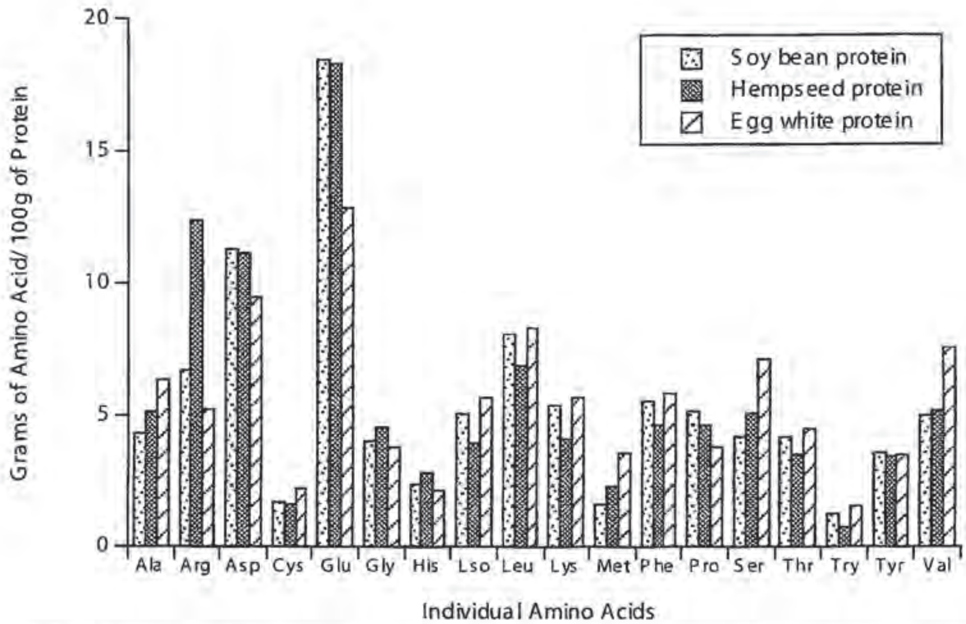

Fig. 6.1. Amino acid profiles of soy bean, hempseed, and egg white proteins, as represented by their IUPAC abbreviations (Callaway 2004). Reprinted with the kind permission of Springer Science and Business Media.

soy and most other vegetable products. This means that, like egg white, a greater proportion of the protein found in hempseed is digested and available for absorption. Recent interest in hempseed protein has increased due to its exceptional content of sulfur-containing amino acids (Callaway 2004, Tang et al. 2006), i.e., methionine and cystine (Odani & Odani 1998), and its surprisingly high amount of arginine (Fig. 6.1). As with most vegetable proteins, hempseed is considered to be lacking in the essential amino acid lysine, and is therefore not sufficient as the sole source of dietary protein for children under 10 years of age, according to FAO/WHO essential amino acid requirements (WHO & FAO 1995).

The major protein found in hempseed is edestin, which accounts for about 60-80% of the total protein content, with albumin making up the balance (Odani & Odani 1998, Tang et al. 2006). Edestin is a well-characterized protein, with a rich and detailed past (Osborn 1892) that has been nearly forgotten today. As with the soy protein glycinin, edestin is a hexamer, being composed of six identical AB protein subunits with molecular weights of about 33.0 and 20.0 kDa (Patel et al. 1994). An interesting non-food application for hempseed protein isolate derives from its ability to form cast films, which can be used in the production of biodegradable and even edible food packaging (Yin et al. 2007). In this study, the physical properties of cast films from hempseed protein isolate were investigated and compared to those of soy protein isolate. Their results suggest that hempseed protein isolates had good potential for the preparation of protein films and demonstrated some superior characteristics over soy isolates, such as low aqueous solubility and high surface hydrophobicity. Both of these properties are extremely important characteristics for durable food packaging of products having high moisture content.

Economy of Hempseed and Hempseed Oil

Neither hempseed nor hempseed oil are among the 200 primary commodities that are tracked by the FAO. However, some limited amount of information is available for both. Hempseed oil production data from the FAO is important to consider (FAOSTAT 2007), and clearly shows China to be in the lead (Fig. 6.2). Figure 6.2 shows worldwide reported data for hempseed oil production from 1994 to 2004, with individual contributions from the major participants, Western Europe and China. It is important to note that the hempseed oil production reported to FAO is probably almost entirely for non-food, industrial purposes; e.g., in the production of paints, varnishes, resins and some bio-plastics such as linoleum. The main reason for presenting this information in this context is to give some idea of the recent scale of reported industrial hempseed oil production worldwide. Unfortunately, the FAO does not have more extensive information on hempseed oil production, and nothing at all on products made from hempseed oil at this time.

The FAO began to report worldwide values for hempseed production in 1961. From 1961 to 1975, Turkey led all countries in reported world exports of hempseed until Lebanon dominated the reported market from 1977 to 1985 (data not shown). France, Germany and Chile were also significant hempseed producers from 1961 to 1985, with the Netherlands, Spain, Italy and Yugoslavia also making considerable contributions from Europe during this time. China's reported hempseed exports accounted for almost 77% of the total world exports reported in 1986, with 12,200 metric tons (MT). FAO data for China's hempseed exports, primarily for bird feed, are only available from 1986-1991, with a maximum reported value of 17,777 MT in 1991, and then again from 1998-2005, with an average value of just over 10,300 MT/year during this period of time. Unfortunately, there are no FAO data from the Soviet Union or Russia for hempseed or hempseed oil. This omission is unfortunate because of the long history of hemp production in Russia. Although production of hemp in this region of the world was primarily for bast fiber, which was used to produce durable fabrics, the production dietary hempseed oil was also important side product for "peasants" who could not afford butter (Grigoryev 2005). In Russia, hempseed oil is still referred to as 'black' oil because of its dark green color and, from 1925 to 1929, hempseed production was reported to be just over 500,000 MT/year (Kaufmann & Juschkewitsch 1930).

As a commodity, hempseed and hempseed oil occupy markets similar to flaxseed and flaxseed oil, with the latter production being about 70 times more than that of hempseed from 1999 to 2004, according to FAO data. Like hempseed, only a rela-

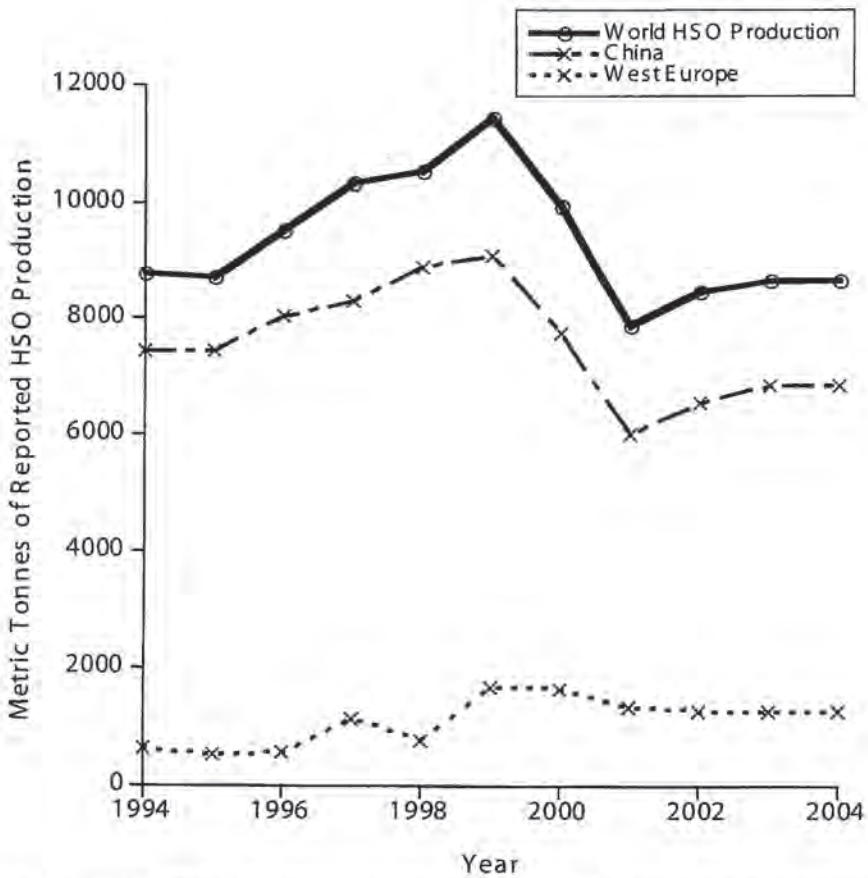

Fig. 6.2. Hempseed oil (HSO) production from 1994 to 2004, according to the United Nations Food and Agriculture Organization (http://faostat.fao.org/).

tively small amount of flaxseed is cultivated for the production of human foods, while most flaxseed oil goes for industrial purposes, such as the production of paints, with the seed meal being used as a vegetable protein additive in animal feed.

Bulk quantities of food-grade hempseed and hempseed oil from Canada and Europe are still relatively expensive, as the cultivated area has not yet reached the levels of other grain commodities, and production costs are still high. Most hempseed for human food is produced in temperate climes throughout the world, although one early-maturing oilseed variety (i.e., Finola) grows well in the arable regions of subarctic Canada and northern Europe (Callaway, 2002). So far, Canada seems to be the largest producer of food-grade hempseed and hempseed oil. From Canada, food-grade hempseed in lots of 1 MT or more costs about € 0.90/kg for conventional grain and about € 1.50/kg for certified organic grain. Bulk hempseed oil from Canada, in

1000-L bladders, may cost about € 5.00/L for conventional and € 9.50/L for certified organic. Retail unit prices vary considerably, along with quality; however, a direct correlation may not necessarily exist between price and quality, in most cases. Hempseed oil is typically sold in retail units of 250–500 mL, with conventional oil currently retailing at about € 6–7 for the smaller size and € 10–11 for the larger size. One can find certified organic hempseed oil for about € 9–10/250 mL and € 14–15/500 mL. European production of dietary hempseed and hempseed oil has lagged behind that of Canada, plus the costs of food production are higher in Europe, with the areas of cultivation being considerably smaller. For these reasons, retail prices for hempseed oil in Europe are currently about 20–30% higher than prices in Canada.

In Canada, 256 MTs of food-grade hempseed were exported in 2006, and 306 MTs were reported to have been exported by May of 2007, according to Agriculture and Agri-Food Canada. If 600 MTs were exported from Canada in 2007, then this would amount to about 3% of the world's exported hempseed. Over 90% of Canadian hempseed export is sterilized and sent to the United States for the production of human foods, where one is still forbidden to cultivate industrial hemp crops for any purpose, and viable hempseed in the United States is indiscriminately lumped into the same legal category as drug-*Cannabis*.

According to the FAO, most varieties of hemp are cultivated for fiber. However, a harvest must produce a sufficient amount of seed to allow for cultivation in subsequent years, and some of this is inevitably utilized for food. Only a few varieties of hemp (e.g., Finola, Craig, and USO-31) are designated specifically as oilseed varieties.

Hempseed Oil Processing

Hempseed oil that is used for human consumption is ideally produced from fresh, well-cleaned seeds that were air-dried at low temperatures (<25°C) over several days or weeks. At the time of harvest, the hempseed moisture content is typically 15–20%. The final moisture content of hempseed for storage and pressing should be just below 10%, and one must take special care to insure that the seed does not support mold growth between the time of harvest and the time of drying. If special care is not immediately taken at harvest, the aesthetic qualities of the product will suffer greatly, and the resulting oil will have a relatively short shelf life of only a few months, at best. Bulk oil stored in glazed-metal, ceramic, or glass containers is preferred after pressing; then the oil is either filtered for immediate bottling into glass or allowed to settle before it is bottled for retail distribution. The fine sediment from freshly pressed hempseed oil has a high nutritive value, and one can use it directly as a nut-butter spread or in other human-food products, or in high-end pet foods.

As oxidation was noted as the main problem for the long-term storage of any polyunsaturated oil, one should take special care to insure that the seed is already under an inert atmosphere before it reaches the press head, and one must maintain this inert atmosphere throughout the processing until the oil is bottled and capped. After bottling, one should protect the product from light and store it at the coldest temperature possible. No worry exists of oil expansion and subsequent container damage when it has solidified at low temperatures (<–20°C), in contrast to frozen aqueous products.

In reality, the ideal scenario is seldom the case. Most contemporary producers of hempseed oil are either individual operators with a small press or small start-up enterprises with one or two presses. Unfortunately, hempseed is rarely pressed under an inert atmosphere, but most reputable processors and distributors will at least state a "best before" date on their products. However, these dates are often quite arbitrary and typically stated to meet some economic objective. Most distributors, and especially retailers, are very reluctant to accept products with short "best before" dates, and too many processors are willing to provide a date that is acceptable to the retailer, with little or no regard for the actual quality of the oil that eventually reaches the consumer. Most retailers that carry hempseed oil are small shops that specialize in "biological/ecological/health/organic" foods, and often have little experience with, or appreciation for, the storage requirements of such a highly unsaturated oil. Moreover, many retailers have little or no spare refrigerated space for "yet another" product and so, unfortunately, often leave highly unsaturated oils to more rapidly age on room-temperature shelves. In the past few years, hempseed oil has begun to appear on the shelves of main-stream food stores in the United Kingdom.

Currently, food-grade hempseed oil for human consumption is cold-pressed from hempseed (i.e., small-scale screw presses operating at 40–50°C). The oil is allowed to settle for at least one to two weeks, and is then decanted directly into smaller containers for retail sales. Larger screw presses are used for "industrial" production, and the more successful operations filter the fine sediment directly into bulk 1000 L containers, rather than wait for gravity sedimentation.

Bulk hydraulic pressing offers a viable economic alternative to cold-pressing for food grade hempseed oil, providing that subsequent processing is under inert atmosphere, but such facilities are usually not set up for the production of high-quality hempseed oil. More importantly, the current market for food grade hempseed oil is not nearly at the level required to take advantage of this processing method. In addition, industrial refining or bleaching of hempseed oil to remove chlorophyll and other components will also remove the characteristic taste, antioxidants and other useful components from the oil.

Supercritical carbon dioxide can also be utilized for the extraction of food oils under low temperature and inert atmosphere. However, the main drawback of this technology is cost. Solvent extraction is used for the inexpensive industrial processing of many vegetable oils, although it is not suitable for the production of human food or animal feed because residual solvents (typically hexanes) contaminate the final product.

Current Applications of Hempseed Components

As mentioned in the Introduction, and presented in Tables 6.1, 6.2 and 6.3, hempseed is an incredibly rich source of beneficial dietary components. The demonstrated health benefits of hempseed and hempseed meal, primarily as animal food, is discussed in the following section. It is worth mentioning that a protein powder from sieved hempseed meal is currently the major human food product made from hempseed in Canada today. This is sold as a protein supplement that is added to baked goods, such as bread, and added by consumers to beverages such as smoothies. Pure edestin, a white protein powder isolated from hempseed meal, is commercially available from China, but the price of this material is currently more than twice that of whey protein. The health benefits of hempseed oil are also discussed in a later section of this chapter.

Nonedible Applications

The primary non-food industrial use for hempseed oil originates from its high level (approximately 80%) of PUFAs (Table 6.2), which readily polymerize upon exposure to atmospheric oxygen. Such 'drying oils' are useful for the production of paints, varnishes, sealants and such durable goods as floor coverings (e.g., linoleum, a floor covering made from flaxseed oil, that was invented in 1860) and other bio-plastics. Highly unsaturated vegetable oils from hemp and flax seeds could serve as hydrocarbon feed stocks for the production of plastics, glues and resins, in much the same way as plastics that are presently derived from petroleum. However, it is unreasonable to expect that seed oils can replace the enormous world requirements for petroleum fuels in the future. Because polymerization occurs more thoroughly with an increasing number of double bonds, the greater amount of unsaturated fatty acids in flaxseed oil results in a harder, more brittle quality in the dried product. This is also why flaxseed based paints, coatings and sealants tend to eventually crack after a few years, while similar products from hempseed oil remain pliable for longer periods of time.

Aside from this, hempseed oil has also found some limited use in body care products, particularly soaps and shampoos. However, most products seek to gain more value by simply stating the presence of hemp on the label, rather than having much of it as a physical component. The idea of using hempseed oil in a soap or shampoo does have appeal, but without adequate precautions taken in the formulation and packaging, these highly unsaturated hydrocarbons will oxidize faster than vegetable soaps made from palm or olive oils. Such an oxidized product, containing oil polymers, may leave a residual greasy feeling on the skin, which can be difficult to completely rinse away. On the other hand, EFAs and especially GLA and SDA, do find a demonstrated utility in skin creams and moisturizers, provided that these PUFAs are not oxidized before they are applied. Although triglycerides do not penetrate healthy skin to any significant extent, they do promote healing of dry and damaged skin, where blood vessels are closer to the contact surface and PUFAs can act directly on locally damaged epidermal tissues.

Applications of Hempseed and Hempseed Meal

Most of the world's hempseed is consumed by small birds, primarily as commercial birdseed, which is the major use of exported hempseed from China. Wild birds also take their share of seed in the field and after storage. The flocking of migratory birds in a field of mature hempseed is a very good indication for the time of harvest. Birds fare well on a diet of hempseed, either as whole seed for migratory songbirds, or as feed made from hempseed or hempseed meal for domestic poultry. Hemp is also an excellent game crop that also provides cover for a wide variety of birds and other animals, with the short oilseed hemp varieties providing a safer environment for hunters to more easily see each other. It is not uncommon to observe geese trampling hemp crops at high northern latitudes, to gain access to the nutrient-rich seed (unpublished observations). Moreover, the flocking migratory birds and small mammals that inhabit oilseed hemp fields throughout summer, and especially near harvest time in the late autumn, attract raptors such as hawks and falcons, offering dynamic displays of predator versus prey action.

The main advantage of hempseed meal over rapeseed and flaxseed meals in animal feed is the lack of anti-nutritional components and toxic glycosides (Matthäus 1997). Linamarin, lotaustralin, and other cyanogenic glycosides are present in flaxseed and flaxseed meal at about 0.2% each (Palmer et al. 1980). Raw, whole flaxseed and flaxseed meal that has been heated only to 'cold-pressing' temperatures (e.g., 40–50°C) can be toxic to animals, especially if the seed or the cake is wetted before processing into feed. Under moist and acidic conditions, the seed enzyme linease will release prussic acid (i.e., hydrogen cyanide gas, HCN) from the glycoside. Some naïve flaxseed oil producers even unknowingly advertise the 'delightful almond flavor' of HCN in their product! Bioactive, and especially toxic, levels of HCN limit the amount of flaxseed meal that may safely be fed to poultry and other animals (Wanasundara & Shahidi 1998). Under high-temperature treatment, such as boiling for 10 minutes or steaming under pressure, linease is destroyed and the immediate release of HCN from flaxseed meal can be significantly reduced, although these cyanogenic compounds also spontaneously release HCN over time (Frehner et al. 1990). Extraction with chloroform, dichloromethane, trichloroethylene or carbon tetrachloride removes the glucoside, but subsequent residues of these halogenated solvents will always remain in the meal. Using hempseed, which lacks these toxic factors, avoids the additional costs of high-temperature treatment or solvent extraction to remove or reduce the risk of HCN in flaxseed products.

According to the FAO, the primary use of hempseed meal is for fattening cattle (supplements to 3 kg per day) and sheep (supplements to 0.5 kg per day). The utility of hempseed meal in feed for ruminants and laying hens has more recently been investigated in Canada. For example, Mustafa et al. (1999) described hempseed meal as an excellent source of rumen undegraded protein. Silversides et al. (2005) found that increasing the amount of hempseed meal to 20% of the feed in the diet of laying hens led to significant increases in levels of EFAs and decreased levels of palmitic acid in their eggs.

Flavor and Aroma Components of Hempseed Oil

Fresh, cold-pressed hempseed oil from good quality seed typically offers a delicious combination of citrus, mint and pepper flavors from the oil. These organoleptic components can vary according to seed variety and growing conditions, but is particularly dependent upon the way the seed is dried and stored. The delicate flavors in hempseed oil result primarily from volatile terpenes (Mediavilla & Steinemann 1997, 1998, ElSohly 2002). Thus, it is extremely important to dry hempseed slowly, and at low temperatures (<25°C), to its target moisture content of just under 10%. Fast drying, especially at elevated temperatures, not only makes control of seed moisture difficult, but also results in a subsequent loss of the delicate flavors. The seed also acquires unwanted tastes and smells that are reminiscent of jute rope or burlap sacks (Fig. 6.3) due to oxidation. For these reasons, hempseed oil should ideally be pressed from seed that is not over one year old.

The taste and smell of paint in hempseed oil is the inevitable result of liberated free fatty acids from the triglyceride, and fatty acid oxidation. Fungal infection of seed that is not properly dried can leave sharp odors of fish or ammonia. A fruity smell can eventually develop in hempseed oil through the gradual production of aliphatic esters from oxidized fatty acids (deMan 2000).

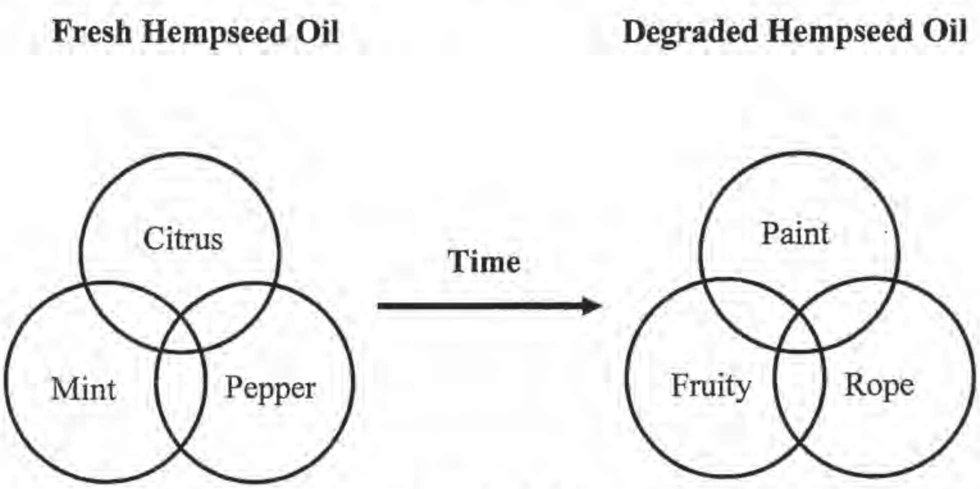

Fig. 6.3. Major organoleptic properties in fresh (left) and degraded (right) cold-pressed hempseed oil.

Possible Allergic Reactions

To date, no reports exist of allergic reactions to hempseed oil. However, importantly, note that hempseed is technically a nut, and one of the proteins in hempseed is albumin, so people with nut and/or egg allergies should certainly be careful when trying hempseed foods, as with any new food. However, in light of this information and the wider availability of hempseed foods over the last decade, surprisingly, only one published medical report exists of an allergy that a hempseed food product could have reasonably precipitated. In 2003, an allergic reaction was reported after an individual consumed part of a restaurant meal that contained dehulled hempseed (Stadtmauer, 2003).

Before hempseed foods became widely available, allergy reports were limited to medical studies on respiratory problems in workers who processed hemp fiber (also common with other natural fibers) under the very dusty industrial conditions which existed until the early decades of the 20th century. Similarly, one other report on a possible allergic reaction to hempseed, as birdseed, merits a mention. The reported context was vague, yet it seems as if the allergy was precipitated by dust from unclean birdseed (i.e., hempseed), which the person possibly inhaled while feeding a pet bird (Vidal et al. 1991).

From the evidence thus far, it seems safe to say that hempseed foods, and particularly hempseed oil, are no more allergenic that other common foods, and probably much less so.

Health Benefits of Hempseed Oil

Although there are numerous articles on the health benefits of polyunsaturated oils (PUFAs), there are very few published studies, to date, on the nutritional effects of dietary hempseed oil, and fewer still that can be considered to be well-controlled clinical investigations into its putative health benefits. Aside from the inherent merits of the fatty acid profile for explaining the beneficial effects of hempseed oil (Table 6.2), the molecular distribution of individual fatty acids on the glycerol molecule of dietary triglycerides offers another important piece of evidence to consider (Table 6.5).

In dietary oils, the fatty acids on the outer positions of the triacylglycerol (TAG) backbone (i.e., the sn-1 and sn-3 positions), are readily hydrolyzed during digestion by pancreatic and lipoprotein lipases, primarily in the duodenum (for a recent review, see Karupaiah & Sundram 2007). The remaining fatty acid at the sn-2 (center) position of the newly formed monoacylglyceride is substantially preserved in chylomicrons, where a new triglyceride may then be reconstructed with other fatty acids in the body. Alternatively, this monoacylglyceride may serve as a precursor in either gut or liver phospholipid syntheses. Thus, preservation of the native fatty acid in the sn-2 position has a prolonging effect in subsequent metabolic processes, such as construction of the phospholipid bilayers of all living cells. Clearly, there is considerable benefit in having the EFAs (i.e., LA and ALA) at the center of the TAG structure, the sn-2 position, for long-term health effects from dietary oils. From the information in Table 6.5, it seems that hempseed oil is the only commercial food oil that can deliver both EFAs at the sn-2 position in significant amounts, as the triacylglycerols LnLLn, LLL and LLnLn make up about 45% of the total found in hempseed oil.

The motivation to investigate possible improvements in health from dietary intake of hempseed oil has come from folklore, traditional medicine, and modern anecdotes derived from the introduction of hempseed foods to modern consumers in Europe and North America. Such contemporary stories began to circulate during the 1990s, particularly concerning the ability of dietary hempseed oil to improve skin quality and certain skin conditions, within a couple of weeks, when taken in modest daily amounts as a dietary supplement. Due to the lipophilic character of the oil, and exceptionally high content of PUFAs, it is readily absorbed for metabolism and immediate use, or stored in adipose tissues for later use. For example, hempseed oil is not an effective laxative, even in relatively large amounts (100-200 ml), due to its rapid absorption and low content of saturated fats. Another consistent anecdotal report from consumers over the last decade is that dietary hempseed oil results in thicker hair and harder nails. These later effects are noticed only after several months, due to the slower growth of these dermal tissues, when compared with the rate of squamous cell turnover in normal skin. Not surprisingly, skin, hair, and nails develop from the same dermal stem cell line, and it seems that the PUFAs in hempseed oil are critical to the appropriate construction and subsequent function of these similar tissues.

Brittle hair and nails are certainly not life-threatening maladies, and it is quite possible to go through life with skin that does not retain water very well. However, these superficial imperfections are symptomatic of other cellular processes that are less easily observed, as all cells in the body require a sufficient amount of EFAs in a balance that supports the optimal metabolism of omega-6 and omega-3 fatty acids.

Table 6.5. Stereospecificity (*sn*-1, *sn*-2, *sn*-3) of the Predominant Triacylglycerol (TAG) Species Found in HSO, Compared to Other Vegetable Oils

[1]Hempseed oil	LnLLn	LLL	LLnLn
[2]Flaxseed oil	LnLnLn	LnLnL	LnLnO
[3]Rapeseed oil	OOO	LOO	OOLn
[3]Olive oil	OOO	OOP	OLO
[3]Corn oil	LLL	LOL	LLP
[3]Soybean oil	LLL	LLO	LLP
[3]Sunflower oil	LLL	OLL	LOO

Ln = α-linolenate (18:3n-3), L = linoleate (18:2n-6), O = oleate (18:1n-9), P = palmitate (16:0). Sources: [1]Larson & Graham, 2007; [2]Krist et al., 2006; [3]Karupaiah & Sundram, 2007.

Immunity and autoimmune disease are also linked to diet and EFA deficiencies or imbalances (Harbige 1998). So far, only two well-controlled, human clinical trials have been performed with hempseed oil, and both studies resulted in beneficial results (Callaway et al., 2005; Schwab et al., 2006).

In the first of these published studies (Callaway et al. 2005), hempseed oil versus olive oil were compared in a 20-week randomized crossover study of 20 patients with eczema, which is also known as atopic dermatitis. Eczema is a condition of chronic dry skin that is often itchy and painful, and has been linked (e.g., Thijs et al., 2000; Horrobin, 2000) to metabolic disturbances in EFA metabolism. Scratching, typically during sleep, results in abrasions that are slow to heal and easily infected. In the Callaway et al. study, patients were instructed to take two tablespoons of the study oil each day (30 ml/day), and suggestions were given to easily include this amount of oil within their normal diets. Each patient took one of the two study oils for eight weeks, followed by a washout period of four weeks. After the washout period, the patient crossed-over to the other study oil for the remaining eight weeks. Fatty acid profiles were determined from blood triglycerides, cholesteryl esters and the phospholipid fractions. Levels of both EFAs and GLA increased significantly in all fractions after administration of the hempseed oil, with no significant increase in arachidonic acid after the eight-week intervention. No adverse effects were reported by the patients or observed by the clinicians. Skin dryness and itchiness were also measured, and these symptoms improved significantly after hempseed oil, with no corresponding improvements after olive oil treatment. Patient use of topical dermal medications decreased significantly only after hempseed oil consumption. This study concluded that the improvements in atopic symptoms resulted from the balanced and abundant supply of the PUFAs in hempseed oil (Callaway et al. 2005).

In the second published study (Schwab et al. 2006), dietary hempseed oil was compared with flaxseed oil in a group of 14 healthy volunteers. Hempseed oil and flaxseed oil each contain high amounts of both EFAs, but in approximately inverse proportions (Table 6.2). However, flaxseed oil has neither GLA nor SDA. While an excessive intake of one EFA over the other was thought to interfere with their respective metabolisms, through competition for delta-6-desaturase, a controlled clinical study had never been conducted to prove this hypothesis in humans. Again, a randomized crossover design was used, wherein the volunteers consumed 30 ml/day of the study oil, but only for four weeks, with a four week wash-out period between each intervention. The results were striking. Increased levels of both EFAs were again found in blood cholesteryl esters and triglycerides after intervention with both study oils, and considerably more ALA was sequestered after the flaxseed oil intervention. GLA levels increased after ingesting the hempseed oil, but there was a dramatic decrease in GLA after taking flaxseed oil. Thus, it was demonstrated that excessive ALA (the omega-3 EFA) from flaxseed oil does compete for access to Δ-6 desaturase and inhibits the production of GLA from LA (the omega-6 EFA). It was not surprising that GLA increased after hempseed oil, as this fatty acid is a natural component of that oil. The other remarkable finding in this study was a trend towards a lower "total-cholesterol" to "HDL-cholesterol" ratio after hempseed oil, which was not seen after the intervention with flaxseed oil. This effectively means an improvement in the "good cholesterol" over the "bad cholesterol" with dietary hempseed oil, but not with flaxseed oil. Neither any significant differences nor adverse effects were found between the experimental periods for either oil in measured values of fasting serum total lipids or lipoprotein lipids, plasma glucose, insulin or hemostatic factors. It is especially remarkable that these statistically significant findings were obtained from such a small group of volunteers.

SDA, a rare omega-3 biological metabolite of ALA that is present in hempseed oil, was detectable at low levels, but not quantified in either of these two clinical studies, due to its rapid metabolism to longer and more unsaturated omega-3 metabolites. It is a pity that more clinical information is not available for SDA, as it does not compete for delta-6-desaturase (as does its immediate precursor, ALA), and serves as an unrestricted dietary precursor to the biologically active EPA (20:5n3) (James et al., 2003). Moreover, SDA can provide similar metabolic benefits as fish oils, but does not suffer from the organic and inorganic contaminants that are found in fish oils. A recent study with dogs (Harris et al 2007) clearly indicated that SDA supplementation increased levels of EPA in the heart and red blood cells, and concluded that SDA may have utility as a safe, plant-based source of omega-3 fatty acid.

An observational study, with intention to treat, reported on the utility of hempseed oil topically applied to healing mucosal wounds after ear, nose, mouth and throat surgery, and concluded that hempseed oil provided rapid and complete support for wound healing (Grigoriev, 2002). Although triglycerides do not normally pass through intact skin tissues, the oil apparently affected wound healing by direct contact with blood capillaries and deeper tissues of the damaged mucosa. This finding is consistent with numerous other clinical studies that have demonstrated the utility of EFAs and other PUFAs in healing and immune response (e.g., Manku et al., 1982, 1984; Bordoni et al., 1988; Oliwiecki et al., 1991; Sakai et al., 1994; Yu & Björkstén, 1998; Derek & Meckling-Gill, 1999; Harbige et al., 2000; Harbige & Fisher, 2001; Horrobin, 2000; Simopoulos, 2002a & b; Simopoulos, 2006).

The fatty acid profile of hempseed oil (Table 6.2) is remarkably similar to that of black currant seed oil (Laakso & Voutilainen 1996), which also seems to have a beneficial impact on immunologic vigor (Wu et al., 1999; Barre, 2001). Borage, which is rich in GLA, but almost totally lacking in omega-3 PUFAs (Laakso & Voutilainen, 1996), is fairly well tolerated as a source of this fatty acid (Takwale et al., 2003), but perhaps more than just GLA is required in some disease states, such as atopy (Whitaker et al., 1996; van Gool et al., 2003; Callaway et al., 2005).

A porridge made from crushed oats and hempseed is a traditional food in the Czech Republic and other areas of Eastern Europe, much like the Chinese hempseed porridge *hou ma you*. One early published report from the former Czechoslovakia described the use of such porridge in treating children who had tuberculosis (Sirek, 1955). In this interesting report, improvements in the children's health were evaluated by medical diagnosis and confirmed by chest X-rays. Considering what is now known, it seems that a rapid improvement of nutritional input, due to hempseed proteins and PUFAs, was probably responsible for the dramatic results stated in this report. More recent investigations into the role of PUFAs for treating tuberculosis support this suggestion (Anes et al., 2003; Russel, 2003).

In rats, dietary hempseed oil reduced platelet aggregation upon the addition of 5% and 10% hempseed meal, containing residual hempseed oil, to their chow (Richard et al., 2007). These amounts were comparable to relative levels of human consumption. Platelet aggregation and rate of aggregation were significantly inhibited by the presence of both 5% and 10% hempseed meal in the rat chow. These effects were not seen with the control diet that contained a corresponding amount of palm oil. It was concluded that the observed effect of improved platelet function was due to the oil from the added hempseed meal.

Also in rats, an increase in plasma EFA profiles was observed (Al-Khalifa et al., 2007) after feeding them a diet that contained hempseed meal. The results were in line with those already seen in humans with hempseed oil (Callaway et al., 2005; Schwab et al., 2006). Moreover, improved heart function and significant cardio-protective effects were observed during post-ischemic reperfusion after the rats consumed 5 or 10% of their food as hempseed meal (Al-Khalifa et al., 2007). In another study (Karimi & Hayatghaib, 2006), rats were fed whole hempseed for only 20 days, which significantly decreased their mean fasting serum LDL level and significantly increased the mean fasting serum HDL and total protein levels. In that study, the authors concluded that short-term hempseed feeding improved rat blood lipid and protein profiles, and recommended that individuals with high cholesterol and high LDL levels, or those affected with coronary artery and liver diseases, incorporate hempseed into their food preparation. A similar improvement in LDL and HDL levels was also observed as a statistical trend in the aforementioned human clinical trial with hempseed oil (Schwab et al., 2006).

Hempseed Oil Stability

An unfortunate paradox of hempseed oil resides within its unsaturation, as this structural feature makes it both highly nutritious and chemically unstable (deMan, 2000). This vulnerability is not unique to hempseed oil, but is characteristic of any unsaturated oil, and is determined primarily by the degree of unsaturation of each of its component fatty acids, and the percentages of such compounds within the oil. This chemical difference explains why relatively saturated palm and coconut oils are more stable (and also solid at room temperature) than highly unsaturated hemp and flaxseed oils (which are still liquid at very cold temperatures).

Degradative processes in unsaturated oils were originally thought to begin with oxidation of the chemical double bond. Although reactions can occur at this site, the predominant mechanism is now recognized to be a free-radical reaction at the allylic carbon atoms adjacent to the double bond. These methylene carbons are more susceptible to reaction with oxygen due to the low dissociation energy of their hydrogen atoms (Ohloff, 1973). Thus, a predominantly monounsaturated mixture, such as olive oil, has one minor site (i.e., the double bond) and two major sites (i.e., the allylic carbons) of lability on its oleic acid constituent, which makes up over 70% of the fatty acids present.

Multiple bis-allylic carbons are found on fatty acids of greater unsaturation, which makes them proportionately more labile. For example, the additional double-bond of ALA or GLA endows these compounds with twice the instability of LA (Cosgrove et al., 1987). It should be remembered that unsaturated oil is only as stable as the most unstable component molecule, and once oxidative degradation begins, these reactions rapidly proliferate to include previously unaffected molecules. Excellent and detailed reviews of vegetable oil oxidation are available (e.g., deMan, 2000; SRI, 2005).

The potential instability of unsaturated oils is provoked to actually begin the process of oxidation by both intrinsic factors and assorted environmental influences (Sherwin, 1978). The first problem begins when enzymes are released from their proper sequestration within cellular structures of the oil-storage endosperm during the process of extraction. Lipase and lipoxygenase are consequently freed to disrupt triglyceride and fatty acid structures, respectively, immediately upon oil manufacture unless the oil "drip temperature" is hot enough (circa 60°C) to denature these proteins. However, even the relatively low temperatures (> 40°C) of "cold-pressed" oil manufacture promote oxidation when the press screw thoroughly adds atmospheric oxygen, so care must be taken to extract under an inert atmosphere (e.g., nitrogen). In addition, the use of transition metals such as iron, or particularly copper, to manufacture oil-exposed parts of the press is problematic. Trace amounts of these metals (i.e., <1 ppm) can catalyze degradation (Sherwin, 1978), especially if the oil contains significant amounts of the more reactive free fatty acids. Ideally, the working surfaces of press heads should be made from completely inert materials, such as high strength ceramic. Failing that, chelating agents (e.g., citric acid) should be promptly added to the oil, especially if the receiving or bulk-storage vessels are metallic.

Light also accelerates oxidation, and the chlorophyll found in raw, unprocessed oils will accelerate this process through its ability to capture light energy. Therefore, unnecessary exposure to light must be avoided during manufacture, and consumer bottles should be made of dark glass. Opaque plastic is sometimes used, but leaching of plasticizers and other chemical components into the oil may be a health hazard, unless the bottle interior is coated with an acceptable shielding resin.

Differences of stability between any two highly unsaturated oils, such as flaxseed and hempseed, can be observed and are at least partially attributable to the proportions of ancillary components within their respective seeds (Abuzaytoun & Shahidi, 2006), which are co-expressed with the oil. These components include phenolic pigments that act as anti-oxidants, or specific anti-oxidants such as the tocopherols. Tocopherols act as in situ preservatives during natural over-wintering of the seed, or during storage of its unadulterated oil. The various tocopherols differ in their respective anti-oxidant characteristics and biological activities. The alpha isomer of tocopherol (Vitamin E) has a high value in human nutrition, yet is relatively poor as an anti-oxidant (Helm, 2006). In contrast, the beta-, gamma- and delta-tocopherols are not nearly as effective as nutrients, but are 130, 200, or 500 times more powerful, respectively, in their anti-oxidant capacities (Helm, 2006). The primary tocopherol in flaxseed oil is the gamma isomer, with minor amounts of alpha-tocopherol (Abuzaytoun & Shahidi, 2006). Hempseed oil has somewhat more gamma-tocopherol as its major anti-oxidant, with collectively significant amounts of the alpha, beta, and delta isomers (Kriese et al., 2004; Blade et al., 2005; Abuzaytoun & Shahidi, 2006). The addition of ascorbyl palmitate is recommended to synergize the anti-oxidant action of these native tocopherols (Helm, 2006). Minor amounts of other native anti-oxidants, such as plastochromanol-8 (Kriese et al., 2004), cannabidiol (Hampson et al. 1998), or terpenes (Radonic & Milos, 2003), may also contribute to the natural stability of hempseed oil. Overall, differences in anti-oxidant quantity and composition, combined with the much greater amounts of unstable ALA in flaxseed oil, make hempseed oil the more stable of the two (Ramadana & Moersel, 2006). The previously mentioned review of vegetable oil oxidation (SRI, 2005) also contains a comprehensive review of anti-oxidants and oxidation test methods.

Because of the aforementioned oxidative properties, it should be obvious that hempseed oil and other polyunsaturated oils should not be used for frying, and moreover, that frying foods is an inherently unhealthy practice, as even the most saturated natural fats and oils contain some polyunsaturates. In general, the use of hempseed oil in any type of cooking should be limited to the temperature of boiling water. Interestingly, the internal temperature of baking bread does not surpass this threshold (Seiz, 2004). At most, the temperature of hempseed oil should not exceed about 120°C (Oomah et al., 2002), which is approximately the temperature found in pressure-cooking, and then only for relatively short periods of time. Not only are PUFAs vulnerable to high temperatures, but also tocopherols begin to degrade above 50°C, a process which accelerates above 100°C (Kerschbaum & Schweiger, 2007). Observing these use parameters to prevent oil oxidation will easily prevent the formation of the trans isomers (Mjos & Solvang, 2006) formed at higher temperatures (Wolff, 1993, Koletzko & Decsi, 1997), which have been linked to coronary heart disease and other chronic health problems (Woodside & Kromhout, 2005). In general, the best way to use hempseed oil is simply as an ingredient in salad dressings, dips and sandwich spreads, or as a substitute for butter on cooked foods such as bread, pasta, and vegetables.

Whole and De-hulled Hempseed

The tough, fibrous shell of whole hempseed can limit the digestibility of the hempseed meal that is produced as a by-product of oil pressing or extraction. This limitation is dependent on the physical size of the shell particle present in the feed, especially in pig and poultry feeds, according to the FAO. However, whole hemp seed can be fed to poultry and other birds if access to sandy gravel is provided for the avian crop. The hempseed hull is not without value, as it contains considerable amounts of phytosterols such as sitosterol and other nutriceutical components (Jeong et al., 1974; Leizer et al., 2000).

De-hulled hempseed is a new and useful product that was not commercially available before the late 1990s. With the hull removed from hempseed, both oil and protein values increase dramatically (Table 6.1). De-hulled hempseed can be eaten directly or added as an ingredient in the preparation of foods, especially "smoothies." Grinding de-hulled hempseed with water produces a tasty vegetable drink which looks like milk and tastes like walnuts or sunflower seeds. This taste is easily modified by a variety of flavors, ranging from sweet to salty. At a ratio of 1 cup de-hulled hempseed to one cup of water, the resulting 'milk' can be used as a substitute for eggs and dairy products in the production of baked goods. For example, cakes and muffins can be made without milk or eggs, as hempseed proteins will denature in the same manner as egg white to produce the desired texture.

Other Issues

The possibility always exists for the adulteration of vegetable oils, particularly when supplies are limited and unscrupulous individuals try to stretch a limited resource by diluting the more valuable component with something cheaper. Dilution by another vegetable oil will normally maintain the appearance of cold-pressed hempseed oil, due to the high level of chlorophyll in the latter. From our analysis of hundreds of hempseed oil samples, a very few examples of hempseed oil adulteration, presumably with cheaper rapeseed oil, were identified in the mid-1990s by gas chromatography. This was noticed primarily as an unusually high amount of oleic acid (>15%) in these particular samples. Possibly, these samples were adulterated with olive oil, but its higher price and higher level of oleic acid make this choice less likely.

Through carelessness or neglect, dirt and other potentially harmful contaminants can become part of the hempseed oil during the crushing process. Detectable amounts of THC and other cannabinoids can also adhere to the hull of poorly cleaned hempseed. In the past, such poorly crafted oils resulted in a positive urinalysis for *Cannabis* metabolites in some individuals who were subjected to drug-testing procedures that are unable to differentiate between the consumption of illegally smoked drug-*Cannabis* and the legal consumption of hempseed oil (Callaway et al., 1997; Lehmann et al., 1997). A similar dilemma exists with poppy seeds (which contain small amounts of morphine and other opioids), which are popular in many baked goods. In the latter case, drug-testing officials quickly responded by raising the cutoff level for urinary opioid metabolites to a reasonably high level (2000 ng/mL).

Unfortunately, a special form of U.S. hysteria that can only be described as "cannabiphobia" has not allowed for a similarly lucid approach to be applied to hemp foods, apparently in the fear that a few occasional users of drug-*Cannabis* might slip by the detection process. Therefore, the cutoff level for a positive determination of cannabinoid metabolites in the urine remains at the exceptionally low value of 50 ng/mL, which is also the lower limit of quantitation for radioimmunoassay. The nascent hemp food industry in North America was quick to react to the potential negative implications for their customers under the so-called "zero tolerance" policies of the United States. Consequently, industry procedures were instituted to press hempseed oil only from well-cleaned hemp seed of varieties that produce only very low levels of THC (Leson et al., 2000). Such low levels of THC in hemp foods are no longer a cause for regulatory concern in workplace drug testing (Lachenmeier & Walch, 2005).

These onerous conditions originate within a U.S. political landscape that forbids the cultivation of industrial hemp, and intentionally seeks to confuse it with drug-Cannabis, even though hemp is otherwise universally acknowledged as having absolutely no value as a drug substance. Moreover, hemp varieties have been shown to produce more cannabidiol than THC, while drug varieties of Cannabis tend to produce more THC than cannabidiol (Hillig and Mahlberg, 2004; Mechtler et al. 2004). Aside from being a potent, oil-soluble antioxidant and a useful phytochemical marker, cannabidiol can effectively attenuate the putative psychoactive effects of low THC levels by binding to cannabinoid (CB1) receptors in the brain (Pertwee, 2008). Unfortunately, the reasons for this intransigent position towards hemp in the U.S. are essentially doctrinal rather than rational, so it may take a bit more time and public education for hempseed products to become more widely recognized there as uniquely useful functional foods.

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