Project title:	Leeks: Desk study to review and assess existing research into the nutritional and health benefits
Project number:	FV 396
Project leader:	Rachel Pennington, Harper Adams University College
Report:	May 2011
Previous report:	n/a
Key staff:	Rachel Pennington
Location of project:	Harper Adams University College, Shropshire
Industry Representative:	J & V Casey and Son Ltd, Willow Farm, Coningsby Road, Dogdyke, New York, Lincolnshire. LN4 4UY
Date project commenced:	11th April 2011
Date project completed (or expected completion date):	30th May 2011

DISCLAIMER:

AHDB, operating through its HDC division seeks to ensure that the information contained within this document is accurate at the time of printing. No warranty is given in respect thereof and, to the maximum extent permitted by law the Agriculture and Horticulture Development Board accepts no liability for loss, damage or injury howsoever caused (including that caused by negligence) or suffered directly or indirectly in relation to information and opinions contained in or omitted from this document.

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

[Name]
[Position]
[Organisation]

Signature ..... Date .....

[Name]
[Position]
[Organisation]

Signature ..... Date .....

Report authorised by:

[Name]
[Position]
[Organisation]

Signature ..... Date .....

[Name]
[Position]
[Organisation]

Signature ..... Date .....

CONTENTS

GROWER SUMMARY

Headline

Literature shows that there is strong association with *Alliums* and reports of the prevention and even cure of many aliments and diseases, but there is little evidence to indicate any specific parallels with leeks. Detailed research would be needed to support any evidence of the health benefits of leeks.

Background

The health benefits of a diet rich in fresh fruit and vegetables in well known. Some vegetables stand out as being particularly beneficial. Onions are particularly good and it has been reported in the press that onions are good for the digestive and immune system. Leeks are closely related to onions being in the same Alliums family but it is not known whether they have the same health benefits.

Previous research has shown that onions and garlic provide a good source of fibre, folic acid, vitamins B6 and C, manganese and iron. Leeks are less dense than onions and garlic so larger quantities of them may need to be consumed in order to produce similar beneficial effects. Leeks are also generally not eaten as regularly as the bulb onion so the quantities that should be eaten to have a positive affect on the immune system, cholesterol levels and fighting cancer, is not known for leeks.

There is no clear understanding as to what research has been undertaken specifically on leeks. This small desk study would therefore help the Leek Growers Association in planning their future marketing strategies by providing an accurate overview of what material is available. This will also allow the Leek Growers Association to incorporate the results into their own research and development strategy.

Summary

It is difficult to make exact, quantitative and universally correct statements on this subject. There remains, therefore, much potential for further research to clarify the subject of the nutritional and health benefits of *Allium*. From reviewing all of the research available on the

health benefits of Alliums, with special attention to leeks, it is clear to say that Alliums have extensive potential for prevention and even cure of many aliments and diseases, although to say the same about leeks would need to be very much substantiated by detailed research, as these is little evidence that indicate parallels.

Financial Benefits

n/a

SCIENCE SECTION

Introduction

The health benefits of a diet rich in fresh fruit and vegetables in well know. However particular vegetables stand out as being beneficial. Onions are particularly good and it has been reported in the press that onions are good for the digestive and immune system. But is the same true of the closely related leek? It's well known that leeks have similar properties to onions and garlic but are they equally beneficial and can their claims be substantiated? Readily available information reports that they provide a good source of fibre, folic acid, vitamins B6 and C, manganese and iron. However since leeks are less dense than onions and garlic, larger quantities of them may need to be consumed in order to produce similar beneficial effects. Leeks are also generally not eaten as regularly as the bulb onion so what quantities should be eaten to produce those famous good effects on the immune system, cholesterol levels and fighting cancer that has been reported for the closely related onions and garlic.

It is thought that there may be substantial information available in literature on the health and nutritional benefits of leeks. This small desk study would therefore help the Leek Growers Association in planning their future marketing strategies.

Currently there is no clear understanding as to what research has been undertaken specifically on leeks. This desk study will provide an accurate overview of what material is available and will allow the Leek Growers Association to incorporate the results into their own research and development strategy.

Materials and methods

This desk research will make full use of existing texts from the Harper Adams University College library and electronic databases, papers in trade journals, and other existing literature available to Harper Adams University College.

Discussion

There is a growing interest in the relationship between food and life-style-related diseases such as cancer and heart disease amongst people all over the world. The *Allium* genera has over 500 members, each differing in appearance, colour and taste, but close in biochemical, phytochemical and neutraceutical content. Historically, these species have been utilised in folk medicine or the treatment of such varied physical disorders as burns, wounds, headaches, chest colds, and rheumatism. The edible Alliums are of major economic and dietary importance in all parts of the world.

Unfortunately the leek, *Allium ampeloprasum* var. *porrum* (L.), also sometimes known as *Allium porrum*, has received less research attention than other Allium vegetables (especially garlic and onions) and for this reason there is less documentation of their likely health benefits.

According to USDA (2010) per 100g, Fresh leek contains 83g water, 1.5g protein, 0.3g total lipid, 14.15g Carbohydrate by difference, 1.8g fibre and 3.9g total sugars. A full breakdown of proximates, minerals, vitamins, lipids and amino acids of fresh leeks can be seen in Appendix 1.

Alliums were revered to possess antibacterial and antifungal activities, and contain the powerful sulphur and other numerous phenolic compounds which arouse great interest (Griffiths *et al.,* 2002). The high content of organosulphur compounds is believed to be responsible for beneficial effects of *Allium* plants (Kik *et al.*, 2001). The reduced volatile sulphur-containing compounds are the main source of the distinctive odour of *Allium* species. Leeks contain flavonol glycosides, reported to have antioxidant activity (Fattorusso *et al*., 2001). Flavonoids (both flavonols and flavanols) are most commonly known for their antioxidant activity. At high experimental concentrations that would not exist *in vivo*, the antioxidant abilities of flavonoids *in vitro* are stronger than those of vitamin C and E (Manashi *et al.,* 1999). Alternatively, additional research by Lotito and Frei, (2006) and Williams *et al.*, (2004), indicates that, following dietary intake, flavonoids themselves are of little or no direct antioxidant value. As body conditions are unlike controlled test tube conditions, flavonoids and other polyphenols are poorly absorbed (less than 5%), with most of what is absorbed being quickly metabolized and excreted.

Research by Higuchi *at el.,* (2003), suggest that sulphur-containing compounds in Allium species inhibit lipid hydroperoxide (LOOH) formation on human low-density lipoprotein

(LDL). A multitude of in vitro studies has shown that flavonoids can inhibit, and sometimes induce, a large variety of mammalian enzyme systems (Middleton and Kandaswami, 1994). Some of these enzymes are involved in important pathways that regulate cell division and proliferation, platelet aggregation, detoxification and inflammatory and immune response. Thus, it is not surprising that the effects of flavonoids have been found in various stages in the cancer process, on the immune system and on haemostasis in cell systems and animals. Hollman and Katan (1999) suggest that flavonoids which by their chemical nature are antioxidants, might contribute to prevention of atherosclerosis, cancer and chronic inflammation.

The flavonols are often found concentrated in the skin of most onions where they impart the yellow/brown colour (Griffiths *et al.,* 2002). Onions contain 300mg/kg of quercetin, broccoli 100mg/kg, apples 50mg/kg, blackcurrants 40mg/kg and tea 30mg/kg (Hollman and Arts, 2002). Flavonols are also found in the fleshly scale tissue where they give a yellow colour in high concentrations or an ivory/cream hue at lower concentrations. This is in contrast to the flesh of white skinned onions, garlic and leek, which contain only trace levels of flavonols (Patil *et al.,* 1995)

Wood (2010) asserts that leek greens are an excellent source of the lesser-known carotenoids lutein and zeaxanthin. According to research carried out by Hsieh (Hsieh *et al.,* 2001), pressed juice from Chinese chive, which belongs to the same family as Leek, is shown to be very effective in inhibiting a wide range of micro-organisms. Higuchi *et al.,* (2003) demonstrated *in vitro* that sulphur-containing compounds in Allium species revealed a high antioxidative activity in association with Low-density lipoprotein (LDL), it is thought that a high concentration of LDL is strongly correlated with the development of Atherisclerosis, an inflammatory disease. So functional foods that contain antioxidative substances are seen to be connected with the prevention of atherosclerosis.

Alliums contain mainly cysteine sulfoxides and when tissues are chopped the enzyme allinase is released, converting the cysteine sulfoxides into the thiosulfinates, the volatile flavour compounds. These compounds are responsible for the characteristic smell and taste of Allium species. A well-known thiosulfinate is allicin, Han et al., (1995) reported that the antibiotic activity of 1 mg of allicin, which is a (+) –*S*-methyl-L-cysteine sulfoxide, has been equated to that of 15 IU of penicillin. Yin and Cheng (1998) suggest that beside allicin, other compounds could be involved in the antioxidant activity because the allicin concentration was not strongly correlated to the antioxidant activity observed in Allium foods. They also

suggest that heating and the addition of acid should be carefully considered when Allium plants are used in food preparation or food processing for antioxidant protection.

Cancer protection

Diets high in vegetables and fruits (more than 400 g/day) could prevent at least 20% of all cancer incidences (World Cancer Research Fund 1997 in Van Duyn and Pivonka, 2000).

Garlic and onion are believed to protect against cancer because their organosulphur constituents, such as diallyl sulphides (from garlic) and dipropenyl sulphide (from onion), increase the activity of detoxifying enzymes, as demonstrated in the rat model (Munday & Munday, 2001; and Guyonett et al, 2001). Garlic, garlic oil and onion oil have been shown to decrease the number and rate of development of tumors in mice and to suppress the growth of leukemia cell cultures (Griffiths *et al.*, 2002).

Allium containing vegetables contain sulphur compounds known to activate enzyme detoxification systems in the body (Van Duyn and Pivonka, 2000). Micro-constituents that may help explain the protective effect in cancer and heart disease are the sulphur-containing compounds in the Allium family; for cancer, the dithiothiones, indoles, and isothiocyanates in cruciferous vegetables play a potentially protective role (Van Duyn and Pivonka, 2000).

We would expect to see leeks providing measurable amounts of protection against several different types of cancer, mostly likely including colorectal cancer. It's important to remember that even in the absence of research studies to confirm health benefits, leeks still belong to the same Allium vegetable family as onions and garlic and contain many health-supportive substances that are similar to the substances in their fellow Allium vegetables.

Heart disease

According to Van Duyn and Pivonka (2000) current scientific evidence suggests a protective role of fruit and vegetables in prevention of coronary heart disease, and evidence is accumulating for a protective role in stroke. The intake of fruit and vegetables may reduce the risk of stroke up to 25% (Klerk *et al.,* 1998). The antioxidants in fruit and vegetables, such as vitamin C, beta carotene and other carotenoids and flavonoids may reduce the risk

of heart disease by reducing the oxidation of cholesterol in the arteries. Other antioxidant compounds such as sulphur-containing compounds or the Allium family may also help explain the protective effect.

Both flavonoids and vitamin C are strong antioxidants, which are capable of reacting with free radicals and chemically neutralising them. Additionally, vitamin C is the antioxidant substance found in the airway surface liquid of the lung; thus, it is conveniently located to protect the body from harmful oxidants (Hatch 1995). Fruit and vegetables provide dietary fibre and that the insoluble fibre, especially the cellulose in fruit and vegetables, may be particularly important in helping to prevent diverticulosis (Van Duyn and Pivonka, 2000).

Griffiths *et al.,* (2002) states that although there are many claims on health benefits of Alliums, most, with the exception of garlic, have not received any rigorous scientific investigation. In their research Griffiths et al (2002), compare the action of onion with garlic, but then goes on to state that it must be remembered that work on the health benefits of onion is less advanced than that of garlic and although it is natural to assume that the underlying mechanisms may be the same for similar benefits, this may well not be so. This is because the major chemistry of garlic is based on the breakdown of 2-PeCSO, allicin and its derivatives (Lancaster and Boland, 1900). Onion does not synthesize 2-PeCSO and does not produce allicin when crushed (Griffiths, 2002). Onions are a rich source of flavonoids and extensive research has focused on the health benefits of these compounds. However, these compounds are virtually absent in peeled garlic cloves (Koch and Lawson, 1996). Thus, while some commonality of responses between onion and garlic may exist, specific health benefits may reside for each species.

Anti viral properties

Adenoviruses (ADV) cause a variety of human diseases, including respiratory illness, gastroenteritis, related syndromes and neurologic disease. Members of the Allium family have many traditional dietary and medicinal applications as anti-infective agents (Lanzotti, 2006). Allium species such as leek are rich sources of biological volatile and non-volatile compounds, especially quercetin (Block *et al*, 1992, and Fattorusso *et a.l*, 2002). A study by Cai *et al* (2006) demonstrated the antivitral activity of quercetin. In a study by Chen *et al.,* (2011) five members of the Allium family - shallots, leeks, garlic, green onions and onions, were selected to determine their potential for use as anti-adenviral agents for the treatment of adenovirus infections. The shallot powder showed the most potent and selective anti-

ADV activity among the extracts tested. Extracts of garlic and onion showed little activity against ADV. Extracts of green onion and leeks were completely ineffective against ADV replication. Some naturally occurring quercetin compounds were shown to possess antibacterial or antiviral activity. Fattorusso *et al.,* (2001) showed that quercetin content of onions was greater than that in garlic, green onions or leeks but that the fresh garlic extract had greater anti-adenoviral activity than onion extract in this study. Chen *et al.,* (2011) conclude that the anti-adenoviral activity of some Allium plants may be due to a combination of photochemicals rather than due to quercetin alone.

Further research

Griffiths *et al.,* (2002) state that the assignment of a 'health benefit' label to a particular compound is always difficult to justify. Clues are sometimes found in epidemiological data in which studies of a population diet are correlated with the incidence of a particular type of disease. Large scale clinical trials involving volunteers who ingest a specified amount of product over a period of time are often very useful in assessing the efficacy of particular foods in the diet in disease prevention. Frequently though, the trials involve small numbers (a few hundred people) and the relevance is often challenged. In some respects, studies with animals often yield informative results since they can be maintained on specified diets and their intake carefully monitored. Rat, rabbit and dog have been used in Allium studies. At the other end of the spectrum , *in vitro* cell cultures derived from animal (non-neoplastic) and human cell lines are challenged with specific products and chemical markers or cytological changes are assessed such as oxidative DNA damage, apoptosis markers (such as DNA laddering) or increased production of free radical scavenging enzymes. Increased production of free radical scavenging enzymes is viewed as a positive effect; however, whether this translates to a 'health benefit' is unclear. Thus, ascribing compounds that have an attribute of 'beneficial to health' requires the collation of diverse data from many sources and a range of studies.

Conclusions

It seems that there is much information in the research field regarding the health benefits of Alliums as a genus, with most research concentrating on Garlic, followed by onions; however there is very little specific research on leeks. There is vast evidence for positive health effects of Alliums generally gathering from studies ranging from epidemiological data to biochemical chemistry. However Brewster (2008) reminds us that it is important to

remember that the mechanisms for health benefits of different Alliums may not be the same, since the types and amounts of flavour compounds, fructans and flavonols differ between species and even between cultivars. Although there are few reports of the disbenefits from Alliums.

It is difficult to make exact, quantitative and universally correct statements about the nutritional and health benefits of Leeks. There remains, therefore, much potential for further research to clarify the subject. From reviewing all of the research available on the health benefits of Alliums, with special attention to leeks, it is clear to say that many Allium species have extensive potential for prevention and even cure of many aliments and diseases, but to say the same about leeks would require detailed research to be substantiated.

References

Bagchi Manashi, Mark Milnes, Casey Williams, Jaya Balmoori, Xumei Ye, Sidney Stohs and Debasis Bagchi (1999). Acute and chronic stress-induced oxidative gastrointestinal injury in rats, and the protective ability of a novel grape seed proanthocyanidin extract. *Nutrition Research* **19** (8): 1189–1199.

Block, E., Naganathan, S., Putman D. and Zhao, S-H. 1992. Allium chemistry: HPLC Analysis of Thiosulfinates from Onion, Garlic, Wild Garlic (Ramsoms), Leek, Scallion, Shallot, Elephant (Great Headed Garlic) Garlic, Chive, and Chinese Chive. *Journal Agricultural Food Chemistry.* 40, 2418-2430.

Brewster, J.L. 2008. *Onions and other vegetable Alliums.* 2nd ed. Wallingford: CBI.

Cai, S.Q., Wang, X, Yang, X., Shang,M., Ma, C., and Shoyama, Y. 2006. Antiviral Flavonoid-type C-glycosides from the Flowers of Trollius chinensis. *Chem Biodivers*. 3, 343.

Chen, C-H., Chou, T-W., Cheng, L-H and o, C.W. 2011. In vitro anti-adenoviral activity of five Allium plants. *Journal of the Taiwan Institute of Chemical Engineers.* 42 228-232.

Fattorusso, E., Lorizzim, E.M., Lanzotti, V., and Taglialatela-Scafati, O. 2002. Chemical Composition of Shallot (Allium ascalonicum Hort.). *Journal of Agricultural Food Chemistry*. 50, 5686.

Fattorusso, E., Lanzotti, Y., Taglialatela-Scafati, O., Cicala, C. 2001. The flavonoids of leek. Allium Porrum. *Phytochem*. 57, 565-569.

Griffiths, G., Trueman, L., Crowther, T., Thomas, B., and Smith, B. (2002). Onions – a global benefits to health. *Phytotherapy Research, 16*, (7) 603-615.

Guyonett, D., Bellior, C., Suschetet M., Siess, M.H., Le Bon, A.M. (2001*).* Antimutagenic activity of organosulfur compounds from Allium is associated with phase II enzyme induction. Mus Res 495:135.

Han, J., Lawson, L., Han, G., nd Han, P. (1995). A spectrophotometric method for quantitative determination of allicin and total garlic thiosulfinates. *Annals of Biochemistry, 225*, 157-160.

Hatch, G.E. Asthma, inhaled oxidants, and dietary antioxidants. 1995. *American Journal of clinical Nutrition.* 61 625-630.

Higuchi, O., Tateshita, K., and Nishimura, H. (2003). Antioxidative activity of sulphur-containing compounds in Allium species for human low-density lipoprotein (LDL) oxidation in vitro. *Journal of Agricultural Food Chemistry.* 51, 7208-7214.

Hsieh, P.C. (200). Antiomicrobial effect of cinnamon extract. *Taiwanese Journal of agricultural chemistry and food science.* 38, 184-193. In Hsieh, P-C., Mau, J-L. and Huang, S-H. 2001. Antimicrobial effect of various combinations of plant extracts. *Food Microbiology.* 18. 35-43.

Hollman, P.C.H. and Arts, I.C.W. 2000. Flavonols, flavones and flavonols-nature, occurance and dietary burden*. Journal of Science Food Agri*. 80. 1081-1093.

Hollman, P.C.H., and Katan, M. B. 1999. Dietary Flavonoids: Intake, Health Effect and Bioavailabilty. *Food and Chemical Toxicology*. 37. 937-942.

Kik, C., Kahane, R., Gebhardt, R. (2002*).* Garlic and health. *Nutr Metab Cardiovasc Disease*. 11:57.

Klerk, M., Jansen, MCJF, Van't Veer, P., Kok, F.J. Fruits and vegetables in chronic disease prevention. In Van Duyn, M.A. and Pivonka, E. (2000). Overview of the health benefits of fruit and vegetables consumption for the dietetics professional: Selected Literature. *Journal of the American Dietetic Association.* Vol 100. 12. 1511-1521.

Koch, H.P. and Lawson, L.D. 1996. *Garlic, The Science and Therapeutic Application of Allium sativum L. and related species*. 2nd Editions. Maryland: Williams and Wilkins.
Lancaster, J.E. and Boland, M.J. 1990. *Flavour biochemistry*. In Brewster, J.L. 2008. *Onions and Allied Crops Biochemistry, Food Sceince and Vegetable Alliums.* 2nd Edition. pp347-372. Wallingford: CABI.

Lanzotti, V. 2006. The analysis of onion and garlic. *Journal Chromatogr.A.* 1112, 3

Lotito SB, Frei B (2006). Consumption of flavonoid-rich foods and increased plasma antioxidant capacity in humans: cause, consequence, or epiphenomenon*? Free Radical Biology & Medicine* **41** (12): 1727–46.

Middleton, E. and Kamdaswami, C. 1994. The impact of palnt flavonoids on mammalian biology: implications for immunity, inflammation and cancer. In *The Flavoniods: Advances in Research since 1986*. ed. J.B. Harborne. 1st Edition. Pp619-652. Chapman and Hall: London.

Munday, R. Munday, C. M. (2001). Relative activity of organosulfer compounds derived from onion and garlic in increasing tissue activity of quinone reductase and glutathione transferase in rat tissue*.* Nutr Cancer . 40:205.

Patil, B.S. Pike, L.M. and Hamilton, B.K. 1995. Changes in quercetin concentrations in onion (Allium cepa L.) owing to location, growth, storage and soil type. *New Phytol.* 130 349-355.

USDA National Nutrient Database for Standard Reference, Release 23 (2010). Available from http://www.nal.usda.gov/fnic/foodcomp/cgi-bin/list_nut_edit.pl Accessed on 11th May 2011.

Van Duyn, M.A. and Pivonka, E. (2000). Overview of the health benefits of fruit and vegetables consumption for the dietetics professional: Selected Literature. *Journal of the American Dietetic Association. Vol* 100. 12. 1511-1521.

Williams RJ, Spencer JP, Rice-Evans C (April 2004). Flavonoids: antioxidants or signaling molecules? *Free Radical Biology & Medicine* **36** (7): 838–49.

Wood, R. (2010). *The new Whole Foods Encyclopaedia*. 2nd ed. London: Penguin Book ltd.

World Cancer Research Fund. American institute for Cancer Research. *Food, Nutrition and the prevention of Cancer: A Global perspective.* Washington DC. American institute for Cancer Research. 1997. In Van Duyn, M.A. and Pivonka, E. (2000). Overview of the health benefits of fruit and vegetables consumption for the dietetics professional: Selected Literature. *Journal of the American Dietetic Association. Vol* 100. 12. 1511-1521.

Yin, M-C. and Cheng, W-S. 1998. Antioxidant activity of several Allium members*.* J*ournal of Agricultural Food Chemistry.* 46, 4097-4101

APPENDICES

Appendix 1

Nutritional analysis of Leeks (bulb and lower leaf-portion), raw.

Scientific Name: Allium *ampeloprasum*

Nutrient	***Units***	***Value per 100 grams***
Proximates		
Water	g	83
Energy	kcal	61
Energy	kJ	255
Protein	g	1.5
Total lipid (fat)	g	0.3
Ash	g	1.05
Carbohydrate, by difference	g	14.15
Fibre, total dietary	g	1.8
Sugars, total	g	3.9
Minerals		
Calcium, Ca	mg	59
Iron, Fe	mg	2.1
Magnesium, Mg	mg	28
Phosphorus, P	mg	35
Potassium, K	mg	180
Sodium, Na	mg	20
Zinc, Zn	mg	0.12
Copper, Cu	mg	0.12
Manganese, Mn	mg	0.481
Selenium, Se	mcg	1
Vitamins		
Vitamin C, total ascorbic acid	mg	12
Thiamin	mg	0.06
Riboflavin	mg	0.03
Niacin	mg	0.4
Pantothenic acid	mg	0.14
Vitamin B-6	mg	0.233
Folate, total	mcg	64
Folic acid	mcg	0

Folate, food	mcg	64
Folate, DFE	mcg_DFE	64
Choline, total	mg	9.5
Vitamin B-12	mcg	0
Vitamin B-12, added	mcg	0
Vitamin A, RAE	mcg_RAE	83
Retinol	mcg	0
Carotene, beta	mcg	1000
Carotene, alpha	mcg	0
Cryptoxanthin, beta	mcg	0
Vitamin A, IU	IU	1667
Lycopene	mcg	0
Lutein + zeaxanthin	mcg	1900
Vitamin E (alpha-tocopherol)	mg	0.92
Vitamin E, added	mg	0
Vitamin D (D2 + D3)	mcg	0
Vitamin D	IU	0
Vitamin K (phylloquinone)	mcg	47
Lipids		
Fatty acids, total saturated	g	0.04
04:00	g	0
06:00	g	0
08:00	g	0
10:00	g	0
12:00	g	0
14:00	g	0
16:00	g	0.038
18:00	g	0.002
Fatty acids, total monounsaturated	g	0.004
16:1 undifferentiated	g	0
18:1 undifferentiated	g	0.004
20:01	g	0
22:1 undifferentiated	g	0
Fatty acids, total polyunsaturated	g	0.166
18:2 undifferentiated	g	0.067
18:3 undifferentiated	g	0.099
18:04	g	0
20:4 undifferentiated	g	0
20:5 n-3 (EPA)	g	0
22:5 n-3 (DPA)	g	0
22:6 n-3 (DHA)	g	0
Cholesterol	mg	0

Amino acids		
Tryptophan	g	0.012
Threonine	g	0.063
Isoleucine	g	0.052
Leucine	g	0.096
Lysine	g	0.078
Methionine	g	0.018
Cystine	g	0.025
Phenylalanine	g	0.055
Tyrosine	g	0.041
Valine	g	0.056
Arginine	g	0.078
Histidine	g	0.025
Alanine	g	0.074
Aspartic acid	g	0.14
Glutamic acid	g	0.226
Glycine	g	0.069
Proline	g	0.066
Serine	g	0.092
Other		
Alcohol, ethyl	g	0
Caffeine	mg	0
Theobromine	mg	0

Source: USDA National Nutrient Database for Standard Reference, Release 23 (2010)