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The influence of product attributes, consumer attitudes and characteristics on the acceptance of: (1) Novel bread and milk, and dietary supplements and (2) fish and novel meats as dietary vehicles of long chain omega 3 fatty acids

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ABSTRACT

Two conjoint studies were undertaken in the USA on relative preferences for sources and food vehicles for long chain omega-3 fatty acids (LCO3FA). Study 1 (n = 202) investigated consumer acceptance of the source of LCO3FA (fish oil, algal oil and novel oilseed) in the most popular, well established vehicle foods (bread, milk and supplements). Study 2 (n = 211) investigated consumer acceptance of the source of LCO3FA (fish-meal, novel oilseed and fish oil) used to enrich the diet of animals for meat production (beef, chicken, pork and fish). Product concepts were varied by base product (vehicle); source of LCO3FA; information source; health claim and additional cost.

These samples of US consumers reported preferences for novel (genetically modified, GM) oilseed incorporated into enriched foods (i.e., bread, milk and supplements) and also for meats above fish and fish oil as sources of LCO3FA and vehicles for consumption. Overall conjoint analysis revealed a general positive relative utility (worth or value) for novel oilseeds which were related to neutral or positive attitudes towards GM.

Generally, the acceptance of enriched foods was dependent on the type of the base food and the cost of fish, with bread preferred over milk and supplements. Similarly, for meat, base (vehicle) product was significantly the most important driver of preference, with about 80% of the sample expressing highest preferences for chicken, fed oilseed (as a source of LCO3FA). However, cost was not an important driver of acceptance of meat alternatives.

Further, knowledge that the novel oilseed was derived from a GM source did not impact on the acceptance of food alternatives. Thus, incorporating GM oilseeds rich in LCO3FA into animal feed, particularly for chicken and beef, and for enriching bread was found to be acceptable amongst the majority. These two studies suggest the existence of a potential demand for novel 'non-fish' source of LCO3FA, providing potential health benefits not currently realised.

1. Introduction

Long chain omega-3 fatty acids (LCO3FA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), have a large range of specific health benefits (Abeywardene, Nichols, & Singh, 2005; Bucher, Hengstler, Schindler, & Meier, 2002; FDA, 2004; Kinsella, Lokesh, & Stone, 1990; Wang et al., 2006) despite a recent Cochrane review (Hooper et al., 2004) finding inconclusive results. In the USA, qualified high level health claims pertaining to LCO3FA are permitted by the US Food and Drug Administration, for products rich in EPA and DHA (FDA, 2004; Rowlands & Hoadley, 2006).

1.1. Low intakes

In many developed countries, the consumption of LCO3FA falls short of recommended intakes (Kris-Etherton et al., 2000; Meyer et al., 2003; National Academy of Sciences, 2005). For example, recent US estimates of EPA and DHA intakes were between 56 and 100 mg/d, suggesting a large shortfall in intakes (Kris-Etherton et al., 2000; National Academy of Sciences, 2005).

1.2. Current supply and barriers to consumption

Currently, oily fish (e.g., salmon) are the only rich source of LCO3FA (EPA and DHA) available (Nichols, 2004). To meet recommended daily intakes, a minimum consumption of two servings a week is required (Kris-Etherton et al., 2000); however, fish intake

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in the US is low (Kris-Etherton et al., 2000; USDA/Economic Research Service, 2005).

Furthermore sustainability of the supply of current foods (fish) containing LCO3FA remains an issue worldwide (Naylor et al., 2000). Fish farming can contribute to fish supplies only if current use of fishmeal and fish oil for aquaculture can be reversed (Naylor et al., 2000).

Due to the possibility of toxic contaminants (organochlorins: PCBs, toxaphene and dieldrin), the US government advises restrictions on the consumption of certain LCO3FA rich fish for large sections of the population (US Department of Health and Human Services and US Environmental Protection Agency, 2004). For example, recommended consumption of farmed salmon is once a month or only once a week for wild salmon (Hites et al., 2004). Hence it is not possible to consume safe quantities of wild or farmed salmon in order to achieve the potential protective effects of EPA and DHA (Foran et al., 2005). However, altering farmed fish's diet from (potentially contaminated) fishmeal, to novel oilseeds high in LCO3FA, may ameliorate contamination problems, resulting in benefit to producer, consumer and the environment.

1.3. Potential solutions

In an effort to increase intakes, one recent approach has been to enrich common foods such as milk and bread products (Garg, Wood, Singh, & Moughan, 2006; Yep, Li, Mann, Bode, & Sinclair, 2002), and also supplements, with microencapsulated fish oil. Most recently various meats and meat products have been enriched with LCO3FA via the animals' diet (e.g., feeding animals' fishmeal) (Kitessa et al., 2004; Wood, Enser, Fisher, Richardson, & Sheard, 1999). However, similar to the enriched foods, bread and milk, the consumption of the enriched meat products would need to be significantly higher to achieve recommendations, than if it were obtained from eating fish as the content of EPA and DHA in the enriched foods is limited (Kitessa et al., 2004). Recent USA data (USDA/Economic Research Service, 2005) estimates consumption per capita/per day of popular meats (e.g., beef, chicken and pork) in the USA at 77.06 kg/annum or 211 g (7.4 oz)/day. Based on the amount of EPA and DHA successfully included in lamb using fish oil feed (Kitessa, Gulati, Ashes, Scott, & Fleck, 2001), the US meat supply could potentially provide, on average, 241 mg EPA and DHA per day (~50% of the unofficial recommended daily intake, National Academies of Sciences, 2005). Assuming future improvements in incorporating EPA and DHA into meat, it is possible that meats could provide substantial contributions to LCO3FA intakes. However, enriching animal feed with fishmeal results in an increase in the demand on an already waning fish supply and also results in the potential for contaminants that have accumulated in the fishmeal to subsequently accumulate in the meat.

In previous work, Cox, Evans and Lease (2008a, 2008b) have argued that recommended intakes of LCO3FA may not be met by current aquaculture practices (Naylor et al., 2000) and that there is a need to explore alternative methods of producing LCO3FA (Miller, Nichols, & Carter, 2008; Nichols, 2004). LCO3FA are initially produced by marine micro-algae, consumed by fish which are then consumed by humans as a dietary source of LCO3FA. While algae oil supplements represent 20% of the US market (Frost & Sullivan, 2005), they are currently expensive, uneconomical as animal feed, and most are rich sources of DHA only, not EPA. Thus, an alternative potential solution to solving increasing consumer demand versus declining fish stocks is to transfer the genes responsible for the production of LCO3FA in marine micro-algae to land based plants (Robert et al., 2005). Plants could provide a more sustainable, economical and environmentally renewable source, could supplement or replace fish oil in omega-3 enriched foods and could replace wild fish as feed for the farmed fish, thus resulting in improved sustainability while reducing the cost of aquaculture (without comprising quality). Potentially, plants could also be used as fodder, rather than fishmeal, for livestock and subsequently negate the potential for contamination of the meat. However, it is also known that transgenic technologies such as genetic modification (GM) often generate high perceived risk and aversion in certain cultures (Hansen, Holm, Frewer, Robinson, & Sandoe, 2003; Cox et al., 2008a, 2008b; FAO, 2004). In contrast to many other countries, in the USA it is estimated that 75% of foods contain GM ingredients and there is no mandatory obligation for manufactures to label products as 'genetically modified' (GM). Furthermore, a recent survey (IFIC, 2005) using open-ended questions on issues of food safety and labelling concerns, found over 99% of US consumers were more concerned with sanitation, hygiene and food borne illness issues rather than biotechnology.

1.4. Current research

The current research comprised of two studies. The first study investigated the acceptance of the source of LCO3FA in vehicle foods, bread, milk and supplements. LCO3FA were described as being derived from one of three sources: (1) purified fish oil, described as having no contamination issues pertaining to fishmeal, but limited in supply and unsustainable (Miller, Nicholls, & Carter, 2008), (2) algal oils, also described as having no contamination issues but characterised as expensive and containing predominantly DHA and not EPA (Frost & Sullivan, 2005), and (3) a novel oilseed (Miller et al., 2008; Robert et al., 2005).

A second study explored consumer acceptance of the source of LCO3FA in meat and meat products (specifically beef, chicken and pork in comparison to fish) from enriching the animals' diet. In this study LCO3FA enriching animal feed were described as being derived from one of three sources: (1) fishmeal, described as placing increasing demand on aquaculture supplies and with the potential for contaminants in some fish to accumulate in the fishmeal and subsequently contaminate the animal and its meat, (2) purified fish oil (as above), and (3) novel oilseed (as above).

Importantly, in both studies, the novel oilseed was not labelled as being derived from genetically modified (GM) plants so as to give the studies ecological validity and replicate the current legal and labelling situation in the USA. However, the influence of a GM label on participants' acceptance of particular foods was investigated with both study's participants asked at the end of the task whether inclusion of oilseeds that were produced by genetic modification (transferring genes from marine micro-algae to oilseed plants in order to enhance LCO3FA content) would influence their acceptance of the LC03 vehicle products. These data were used as a variable in the main analyses.

Thus, three fundamental research questions were explored in the two studies:

- What products are preferred by US consumers as vehicles for increasing LCO3FA?
- What sources of LCO3FA are preferred by US consumers to be used to enrich the base vehicle products?
- How do the 'costs' of consuming alternative products influence the utility of a product?

1.5. Theory and calculation

To address these research questions, two interconnected methodologies were used: (1) conjoint methodology (Green & Srinivasen, 1978, 1990; van Kleef, van Trijp, & Luning, 2005), using food product "profiles" to determine the relative utility-disutility (worth or value) of the attributes of current and novel products (a product orientated choice approach), and (2) an adaptation of