

INFLAMMATION, NUTRITIONAL APPLICATIONS & THE CONSUMER MARKET

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Inflammation

Regarding: Inflammatory market, osteoarthritis and nutritional compounds currently attributed to aim inflammatory disease

Inflammation: The body's inflammatory response is an essential protective mechanism.

Acute inflammation is the reaction to protect the body from trauma, pathogens, infection, viruses and/or foreign bodies. Inflammation is mediated by a network of the immune cells, cytokines, cell signalling proteins and enzymic responders. This coordinated response is designed to limit tissue damage, remove the foreign body, and repair the damaged cells or tissues. The rate of response is determined by cytokine signalling that increases protein turnover. If the trauma is to skeletal muscle, accelerated catabolism will occur via protein degradation, as the amino acids are freed from the muscle breakdown they provide a substrate for the liver and immune cells, resulting in the liver down regulating protein secretions and increase the formation of acute phase reactants; c-protein, alpha1-acid glycoprotein and alpha2-macroglobuline (Libby, 2019).

Generally, in older adults and young children inflammation will cause a loss of appetite. This loss of appetite, along with changes to liver metabolism a negative nitrogen balance will occur, causing muscle loss. Muscle tissue degradation can be reduced by increasing protein and antioxidant intake via the diet. By supporting increased nutrient needs from easily digesting proteins and anti-inflammatory agents a faster recovery can be achieved. However exact nutrient turnover is hard to predict (Alwarawrah, Kiernan and MacIver, 2018).

In the case of chronic inflammation and inflammatory disease, the body initiates an inflammatory response without the presence of any foreign bodies, trauma or need to initiate an immune response. The causation is broad, including allergic reactions, long-term oxidative stress caused by free radicals, mitochondrial dysfunction, uric acid production, advanced glycation end products, lipoproteins and high homocysteine levels (Khansari, Shakiba and Mahmoudi, 2009).

In chronic inflammation the increased production of immune cells, macrophages and T-lymphocytes produce cytokines and enzymes which result in long lasting damaging effects to cells and tissues causing pain, fibrous nodules and swelling (Mann & Truswell, 2012). It is this cycle of chronic inflammation and cell damage that is detrimental to health status, which is often caused by poor dietary intake, inactivity and obesity (Egger and Dixon 2014).

The UK anti-inflammatory market- The anti-inflammatory market is dominated by over-the-counter NSAIDS and prescription pharmaceuticals. Approx. 43% of UK adults report living with chronic pain (Fayaz et al., 2019). 28 million adults regularly self-administer NSAID anti-inflammatory drugs (BPS, 2018). The exact number of those who manage pain through diet and lifestyle change is not established but is estimated to parallel the NSAID markets with additional use for preventative illness (NHS, 2019).

Inflammatory disease is a cycle of cause and causation, this is particularly seen in joint pain. Where the pain causes inactivity and weight gain, leading to further inactivity and obesity, muscle wastage and increased prevalence of depression. In 2016-2017, the NHS reported the highest number of admissions

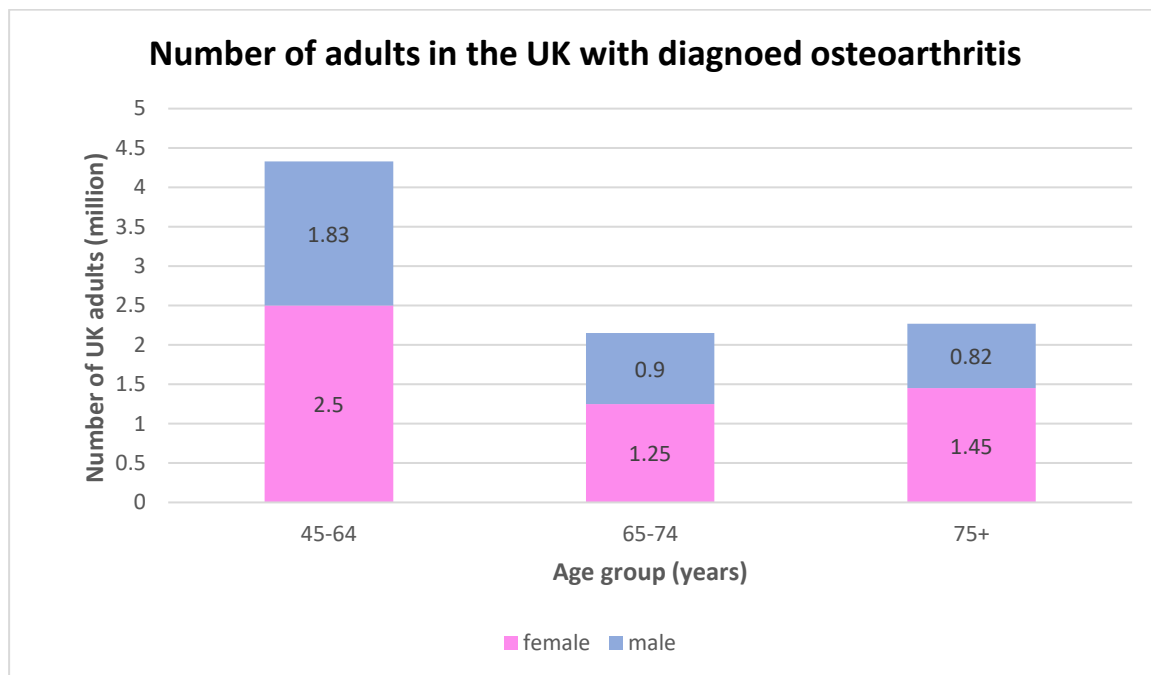
to GP's, for inflammatory associated illness from poor lifestyle habits that resulted in avoidable illnesses; hypertension 13.8%, obesity 9.5%, and depression 8.3% (NHS, 2018).

Inflammation and inflammatory disease span a wide range of diseases and implication. Including but not limited to- Arthritis, Asthma, Dental infections, Diabetes, CHD, Fibromyalgia, Gout, Gut health, IBS and bowel disease, IBS, Crohn's disease, Colitis, Hypertension, Lupus, Neurological disorders, Alzheimer's, Parkinson's, epilepsy, dementia, ADHA, MS, Obesity, Osteoporosis, Osteoarthritis, Psoriasis, Rheumatoid arthritis, Sjogren's syndrome, Bowel cancer, Vascular disease.

Focusing on osteoarthritis- Osteoarthritis is a chronic inflammatory disease in which the bodies joints become damaged, resulting in decreased range of movement (ROM), swelling and chronic pain. This is caused by the degradation of the joint and the bodies inability to repair the joint efficiently. The cartilage becomes rough and thin, ligaments become stiff and the underlying bone thickenings and formation of bone spurs. The synovium also thickens, resulting in swelling and further decreased ROM and pain. In advanced stages the cartilage will be lost, leaving the bones to rub together further increasing pain and joint degradation (Arthritis Research UK, 2019). The main symptom is pain that results in chronic inflammation, reduced mobility, insomnia, fatigue, depression and weight gain.

- The estimated number of those treated in the UK for osteoarthritis is 8.75million or 1/3 of adults aged 45years and over.
- 98% of all knee replacement surgeries are due to osteoporosis and ¼ of those go on to seek treatment for hip conditions.
- Of those aged 75+, almost half of all females and 42% of males have sought treatment for osteoarthritis.
- It is estimated that by 2035 8.3 million adults aged 45-64 will have knee osteoarthritis, the most common form.

(Arthritis Research UK, 2019)



Graph 1: Graph presenting the number of adults in the UK who have sought treatment for osteoarthritis (Arthritis Research UK, 2019).

Combined with an aging population in the UK, the number of those living with osteoarthritis will significantly increase. Women are more susceptible to osteoarthritis than males and the likelihood of having osteoarthritis also increases with age (Anderson, 2019). Osteoarthritis is heavily exacerbated by obesity causing pressure on joints, increased circulation of free radicals and inadequate nutritional intake. Those who suffer with gout and rheumatoid arthritis are at greater risk of developing osteoarthritis. Bone density is another risk factor. Low bone density is linked to rapid progression of knee and hip osteoarthritis. Genetics involved with osteoarthritis are not fully known but are believed to increase risk factors, though can be minimised through diet and lifestyle habits (Bliddal, Leeds and Christensen, 2014).

Diet and inflammation- 75% of all consumers identify a desire to improve their health status, but many fail to do so, mainly due to unpleasant taste and lack of convenience to purchase (Kantar, 2019). It is recognised that the main causation of long-term inflammation is driven by poor dietary habits; overfed yet malnourished populations, obesity, exposure to toxins and inactivity. The food industry and supplement markets have acknowledged the possibility to manage long-term anti-inflammatory illness via foods that liberate the bound medicinal properties (Bost, Maroon and Maroon, 2010). With an aging population, the interest of nutraceutical led alternatives from botanicals, herb extracts and food-based sources has seen a rise within health stores. Also, many suggestions to follow specified diets to manage inflammation are present via online searches but fail to provide credible scientific reasoning.

Foods and extracts on the market aimed to reduce and managing inflammation include- omega 3 fatty acids, pineapple extracts, CBD oil, avocado seed extract, cranberries, berries, tea extracts, antioxidant (vitamin A, C and E) blends.

Many such claims are yet to be backed by scientific trials but do hold sound reasoning. The real need for convenient foods, drinks and supplements that contain anti-inflammatory agents would improve health and potential life quality in many adults.

The popular compounds currently on the market that have links to credible research are-

- Curcuminoids, from curcumin has gained great popularity in recent years, accredited to its anti-inflammatory, anti-oxidant and anti-carcinogenic properties. Papers supporting curcumin's ROS scavenging abilities have concluded that curcumin could be a potential therapeutic agent for endothelial protection against proinflammatory cytokine-induced cytotoxicity in several pathological conditions. (Barbalho et al., 2017).
- CBD has been linked with the reduction of anti-inflammatory illness. A recent study identified CBD's possible abilities to reduce inflammation possibly by the activation of glycine receptors (Nagarkatti et al., 2009).
- Resveratrol is an antioxidant within grapes, blueberries, red wine and peanut butter. Antioxidant traps free radicals and therefore reduces the damage and inflammation caused by such (de la Lastra and Villegas, 2007).
- Ginger has been linked to decreased inflammation of those with kidney disease, reduction in interleukin 6 and cytokines (Nafiseh Shokri Mashhadi, 2019).
- Spirulina has been linked to healthy aging, enhanced immunity and reducing inflammation, reducing inflammatory markers and anaemia (Selmi et al., 2019).
- Alpha-lipoic acid is naturally produced in the body supporting metabolism and energy production, but also functions as an antioxidant helping restore levels of vitamin C and E (Shay et al., 2009).
- Omega3 fish oils have long been claimed to aid joint health. Current research has presented a benefit in reducing inflammation of the heart, diabetes, and gut health. Also, a reduction of interleukin 6 and cytokines have been attributed to regular n3 intakes (Calder, 2010).

Adapting to the market- As the UK and western population are aging, rising in obesity and the occurrence of non-communicable disease the need for healthier food products with clean labels, that are also easily accessible is in great demand. Consumers are also increasingly interested in high protein or protein enriched products due to protein's attributes towards health. Dairy products can take advantage of this consumer trend due to the naturally occurring amino acids profile and protein content, this can be further capitalised on via increasing the protein content; as seen in large sales of high protein strained yogurts. The protein content can demand a higher price, with a recent US study presenting that 55% of those surveyed would pay 10% more for a perceived healthier version of a product, and 23% willing to pay 10-20% more (Deloitte, 2017). Milk consumption per capita has fallen by approx. 6% over the past 5 years, yet the yogurt market and functional food markets are gaining consumer uptake. This is due to yogurt and yogurt style foods being well received for their attributed health benefits, convenience and palatability.

Dairy proteins are considered as the 'best' protein delivery within the sports and active 'fitness/gym culture' consumers, due to their complete amino acids profile, digestibility and palatability (Helms, 2016). Whey, casein and milk fractions are staple components of sports nutrition products driving the IGF1 and GH production, this also lends well to aging populations (ESSEN, 2019).

Healthy aging is an emerging market where dairy can be ideally placed to prevent sarcopenia and bone density loss; marketing this sector is not easy due to age perceptions. However, if the product and marketing is carefully met this is the potentially largest and most lucrative consumer market (Mintel, 2019).

Clinical nutrition is an emerging market to address malnutrition. This is an increasing area in the western populations where overfed-malnourished cases are on the rise. Here presents an opportunity for whey and casein to be used in medicines, and treatments for micronutrient insufficiency due to dairy's naturally occurring vitamin and mineral profiles. The global clinical nutritional market was valued at \$39.4bn in 2015 and expected to grow at a CAGR of 5.4% to 2022 (Deloitte, 2017). This is collated from a range of demographic trends, including ageing population, premature babies, malnutrition and increased incidence of lifestyle associated disease (NutraIngredients 2019).

The nutritional components within bovine milk are all naturally occurring unlike the increasingly popular plant-based milks alternatives, yet the method of usage is generally perceived as a straight swap however, the nutrient values differ considerably. Plant based milk alternatives must be fortified to provide a more complete nutritional composition. A collaborate 'best of both' product, combining the plant and dairy sectors could prove to be a clever nutritional and market move, working with the increasing flexitarian market.

The demand for 'functional foods' in healthy aging, active and sports nutrition markets can be captured by the enhanced-yogurt/dairy products. The demand for food to enhance gut health has seen a rise in the demand, especially towards fermented products (Deloitte, 2017). Dairy products already have an accredited 'article 13, EU health claim' and functional food claim (EFSA 2019). The dairy sector is well positioned to capitalise on this market.

The increased number of the products functionalities adds a higher premium to the product. It is reported that one health associated benefit can increase price command by 9%, two attributed benefits by 16% and three by 24% (Kantar, 2019).

Global Yogurt Market- the global yogurt market accounted for \$77,679 million in 2016, with a forecasted growth to \$107,209 million by 2023, growing at a CAGR of 4.6% from 2017 to 2023. Yogurt is a nutrient dense food product; the sweetened and flavoured markets are dominated by the infant and school aged markets but have been forced to reduce the added sugar contents in line with EU law and the sugar tax (The Food Foundation, 2018).

Yogurt is consumed in various forms, such as; drinkable, snacking, meal replacements for those with poor appetite or poor chewing abilities, as a dessert, as a protein-rich food for active, aging and sports markets, as a breakfast option, as an accompaniment to cereal or fruit. All of which are seen as suitable for all age ranges and health status (with exception of those with lactose allergies or intolerances). The health benefits associated with eating yogurt include aided digestion, lower risk of

type 2 diabetes, protection against colorectal cancer, prevention & treatment of osteoporosis, enhanced weight & fat loss, improved immune system, and reduction of high blood pressure & bad cholesterol (Breen, 2018).

Annual Per Capita Yogurt Consumption

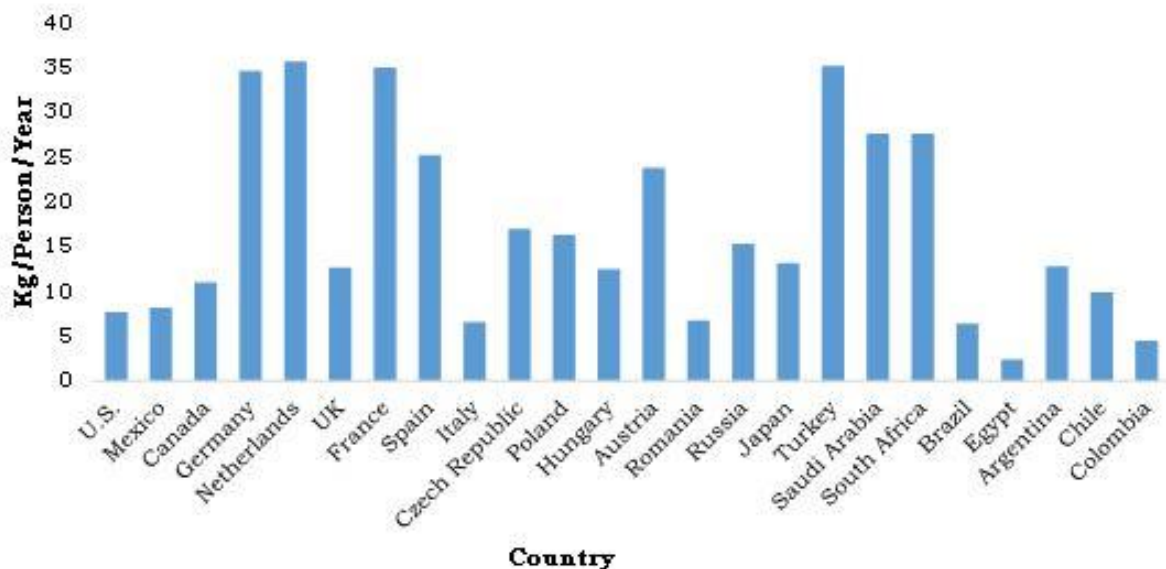


Figure 1; Annual Per Capita Yogurt Consumption across the globe (Allied Market Research, 2017)

The approximate estimate of annual per capita of yogurt consumption clearly indicates that European populations have some of the highest yogurt consumption. This factor places the European yogurt market as a mature and healthy one, in comparison to other global regions.

Growth in the demand for yogurt in the developing nations are projected to rise as disposable income increases along with increased awareness of health are expected to provide numerous opportunities for the development of the global yogurt market (Mordor, 2019).

The global yogurt market is mainly driven by the associated health benefits. Other factors supporting market growth are expansion of retail markets, convince and reducing the lactose content for those with intolerances. Some of the major players pushing the health attributes of yogurt and its convenience include; Yakult, Danone and Nestle (Allied Market Research, 2017).

Research does present a consumer fear by some consumer groups that the use of artificial additives, along with the perception that dairy contains high levels of hormones/antibiotics limit some consumers from purchasing yogurt (Hassien, 2015). The need for clean labelling is essential to gain consumer confidence (Mintel, 2018).

STRAINED YOGURT- A great delivery of dairy and its associated nutritional benefits is consumed via the increasingly popular ‘high protein-strained yogurts’. The varieties with a small (1-5%) fat content are nutritionally favourable, keeping in line with consumer demands for a reduced fat content yet by maintaining a fat content (opposed to 0% fat content) delivers essential fatty acids and fat-soluble vitamins. Yogurts also provides water-soluble vitamins and minerals.

High protein products with 7-10g/100g appeals to market trends of all ages and genders, but particularly well received by the female market, active/sports markets and health food markets (NutraIngredients 2019, The Grocer 2019, Global Research 2018).

The straining process reduces the lactose content (compared to non-strained yogurts), appealing to those influenced by low carbohydrate or low lactose diets.

Live yogurts also provide probiotic properties and highly palatable.

TEXTURE AND PALATABILITY- The texture and palatability factor must be highly considered (RSSL, 2019). Within milk and yogurt, the demand for smooth, creamy textures with neutral tones are preferred by the consumer. Tones or flavour notes of cheese, within yogurts are very off putting and often require flavour masking agents. The use of flavour maskers discourages those consumers who are looking for a clean label and one free from additives (RSSL, 2018).

ORGANIC- Organic food sales are in the eighth year of growth (Organic Soil Association, 2019). The Grocer reported organic sales hit an all-time high of £2.2bn in 2017, with chilled foods and deli products observing the single biggest increase at 21.3% of value sales. The Organic Soil Association have attributed the increased demand of the organic foods to the increasingly health-conscious consumer (Mintel, 2018). Consumers are also increasingly concerned with the provenance and traceability leading to their food choices (Organic Soil Association, 2016).

Interestingly, dairy products continued to claim the biggest share of the organic market, approaching 29% of all organic sales (Organic Soil Association 2016).

INDIAN CUCUMBER AND THE VILLAGE DAIRY- The prospect of a functional natural extract, from Indian cucumbers to aid, prevent or manage inflammatory disease would be well placed within the health, aging, active, sports and female markets. This is heightened by the extract's suspension within a dairy based yogurt. Yogurt is a well-received, popular product with a loyal and expanding consumer base, commonly associated with health and commonly purchased due to its health attributes, however careful consideration to texture and taste must be made.

The blend of the cucumber extract within a nutrient rich yogurt will provide dual benefit; providing multiple functionalities and meet many nutritional needs.