

OAT MARKETS AND NUTRITON

Natalie Rouse

05th SEPTEMBER 2019

OATS; MARKET OPPORTUNITIES, HEALTH AND NUTRITIONAL ATTRIBUTES

- Oats are considered as a 100% whole grain food, as they provide carbohydrates, protein, vitamins, minerals, several antioxidants and are also one of the richest dietary sources of the soluble fibre beta-glucan.
- Oats are high in fibre and have a low GI, which means that they can help in weight reduction by maintaining the feeling of being full for longer.
- Oats have a great potential for use in functional foods for their approved health claims.
- Oats hold an accredited EFSA health and nutrition claims for both adult and child populations.
- Oats are a highly nutritious grain that has maintained a positive reputation with consumers and continues to gain consumer confidence and market growth.
- Oats are highly versatile, with a neutral taste; retained a household staple even when low carbohydrate diets have gained popularity.
- Oats are also suitable for those with celiac disease, gluten-free and vegans.

MARKET SPACE

The Global oat market reached a volume of 23.5m tones in 2018, of which 700,000 tonnes were grown in the UK in 2018 (AHDB 2019).

Oats are grains obtained from the *Avena Sativa* plant which belongs to the *Poaceae* plant species. As the availability of low-cost oat substitutes are discovered and changes in traditional farming methods the usage of oats as an animal feed have declined over the past years. However, the human demand for oats has seen significant growth in the form of breakfast cereals and in baked goods due to hosting a wide range of nutrients such as vitamin E, essential fatty acids, soluble fibres and antioxidants. Oats also contain a high content of beta-glucans which is a lipid lowering agent reducing LDL cholesterol levels, stabilising blood sugar levels, reducing the risk of hormone related cancers (Lehtinen et al 2015). Oats are also used in the production of cosmetic products and in industrial applications.

Increasing awareness of the health attributes of oats has boosted their inclusion and usage in the health food market and in functional/healthy snacking along with traditional uses in biscuits, cakes and breads (Rose 2014). The market is also driven by the substitutable growth in retail outlets and online platforms for easily accessible high-quality oat-based products. The demand of highly nutritious foods that are convenient is propelled by working populations and busy family's lives (Mintel 2019).

Manufactures and food product developer continuously expand their product ranges by introducing oat containing and oat-based products. Due to oats neutral flavour and consumer confidence the addition of oats in beverages, bakes and bars are well received. Oat protein powders and oat milks are gaining interest by the flexitarian and plant-based markets (Forbes 2018).

Oats increasing ingredient role is rapidly growing in multiple consumer markets;

- Oat based snacking markets; \$23.4bn by 2024 (Retail times 2019)
- Breakfast cereal market; \$53bn by 2025 (Grand View Research 2019)
- Functional foods market; \$161.49bn by 2024 (Grand View Research 2019a)
- Health food market; \$811bn by 2025 (Mirror Market 2019)
- Digestive health market; \$5.7bn by 2024 (Transparency Markey 2019)

- Sports/active nutrition markets; \$44bn by 2022 (Zion 2019)
- Weight management market; \$442 by 2022
- Oat based milk alternatives \$16m recorded by 2018 end of year (Financial Times 2018)
- Nutraceutical applications; The nutraceutical market is predicted to be worth 617bn by 2024 (Mordor Intelligence 2019)

The most common food application for oats include oatmeal, oat flour, oat bran, and oat flakes, which are used for breakfast cereals and as an ingredient in food products. The most popular form of consumption is the traditional porridge oats made with semi-skimmed milk and often accompanied with the addition of berries, seeds or honey (Rasane et al 2015).

Table 1; The most common commercial form of oats (The Grain Council 2019)

| | |
|-------------------------|---|
| Raw oats | Newly harvested oats with the kernels (also known as groats) still attached. Pre-processing. |
| Whole oats | Whole oat groats are the result post harvesting, cleaning and removal of inedible hull. |
| Steel cut oats | Groats are sliced in half by a metal blade. Steel cut oats cook quickly due to increased water permeability and particle size compared to whole oat groats. |
| Scottish oatmeal | Scots oats are produced using a steel blade and then ground by stones to create small coarse particles to create a creamy texture when mixed with water or milk. |
| Rolled oats | Rolled oats are produced due to steaming of the groats and then rolled into flakes. The processing allowed the oat to increase the shelf life due to increasing the stability if the oils contained reducing rancidity. |
| Oat flour | Oat flour is a whole grain flour that can be used for baking or for thickening liquids |
| Oat bran | Oat bran is just the bran and doesn't contain the oat germ or endosperm and therefore is not considered a wholegrain |

OAT FUNCTIONALITIES

Oats are used in the preparation of different types of manufactured products such as oat flakes, flour, pastes, oil bakery products, beverages, breakfast cereals and snack products. Oats are used in controlling the texture of various food products and have been used as a fat replacer in dairy, meat and bakery products. Oats are used in the dairy industry as an antioxidant and stabilizer in ice cream and other dairy products and in the manufacture of cheddar and white-brined cheeses. Oat beta-glucan is often used as a thickening agent property in food industry and it may also positively influence the sensory quality of beverages (Walter et al 2018).

Table 2; Oat applications and multiple functionalities (adapted from Zhou 2017).

| Food Uses | Oat component | References |
|--|--------------------------------------|--|
| Bread | Flour Starch Lecithin | Zhang et al (1998) Flander et al (2007) |
| Beverage- oat milk alternatives | Whole | Gusta et al (2010) |
| Biscuits | Flour | Ballabio et al (2011) |
| Breakfast cereal | Whole | Ryan et al (2011) |
| Pasta products | Starch | Chillo et al (2009) |
| Granola bars and cereals | Whole and resistant starch fractions | Hager et al (2013) |

| | | |
|---|------------------------------------|--|
| | | Aigster et al (2011) |
| Infant food | Whole | Del Valle (2010) |
| Oat milk | Whole oat extract | Onning et al (1999) |
| Oat based non-dairy fermented whole oat yogurt | Whole | Maitensson (2001) |
| Fat substitutes meats, dairy and baked goods | Bran | Yilmaz ans Paghioглу (2003) Lee et al (2015) |
| Fat substitutes | Oat dextrin Soluble beta-glucan | Zwer (2004) Sun et al (2008) Shan et al (2011) |
| Stabiliser in ice cream | Beta-glucan | Zwer (2004) |
| Clinical uses | | |
| Gluten free diet | Whole oats | Ballabio et al (2011) Wang et al (2011) |
| Cholesterol lowering effects | Beta-glucan | Kanlon et al (1999) Hallfrish at al (1993) |
| Anti-carcinogenic effects | Beta-glucan | Hscuch (2001) |
| | Short chain fatty acids | Murphey et al (2011) |
| Industrial uses | | |
| Methane bio gas | Husk | Kusch (2011) |

NUTRITIONAL ATTRIBUTES

Oats are among one of the most valuable functional food crops with numerous nutritional, industrial and health benefits. Oats are an easily available food source that can be incorporated into the daily diet. Beside to the soluble fibre beta-glucan content, oats are rich in lipids, protein, B vitamins, minerals, phytonutrients and polyphenols. Oats are also an excellent source of energy, unsaturated fatty acids and lower in carbohydrates compared to other whole grains (Boros et al 2018). Oat beta-glucans are attributed to therapeutic properties such as antioxidant, reducing hypertension, reducing LDL cholesterol, maintaining a stable blood sugar level and therefore aids those who are susceptible to, or have existing T2DM (Hui 2016).

Oat beta-glucan also aids in the regulation of bowel activity and improves gut health that is associated with the reduced risk of various non-communicable disease (Lia 2015). Regular consumption of oats may also help to reduce appetite and control body weight with various studies have shown beta-glucans increases satiety (Cook 2013).

Oats are well known for providing valuable nutrition to support multiple mechanism of human health (EFSA 2019). Healthier breakfast options such as oats are getting increasingly popular along with the rapidly changing breakfast market to that of a convenient breakfast bars, in ready-to-drink (RTD) breakfast shakes and in breakfast/meal powder formulations.

Table 3; Oat nutrient composition (McCance and Widdowson 2015).

| Nutrient composition of non-fortified plain whole rolled oats per 100g | | | |
|--|------|----------------|------|
| Protein | 10.9 | Fat | 8.1 |
| Carbohydrate | 70 | Sat fat | 0.16 |
| Sugar | 0.3 | MUFA's | 0.94 |

| | | | |
|-------------------------|------|--------------------------|------|
| NSP | 7.2 | PUFA's | 0.16 |
| Fibre | 7.8 | KCAL | 381 |
| Na | 1 | K | 372 |
| Ca | 50 | Mg | 114 |
| P | 387 | Fe | 3.64 |
| Cu | 0.37 | Zn | 2.3 |
| Ch | 87 | Mn | 3.66 |
| Se | 3 | I | Tr |
| Vitamin E | 0.59 | Tryptophan | 2.7 |
| Thiamine | 1.05 | Vitamin B6 | 0.34 |
| Riboflavin | 0.05 | Niacin equivalent | 3.5 |
| Niacin | 0.8 | Folate | 32 |
| Pantothenic acid | 0.75 | Biotin | 19 |

FUNCTIONAL FOOD

Oats have various health and nutritional benefits and due to this various new oat products are emerging, creating a greatly dynamic functional food market.

Oats have gained the recognition for being a functional food. A food that is regarded as 'functional' can provide benefits to one or more physiological processes beyond that of 'normal' adequate nutritional effects presenting improvements in the state of health and/or reduction of disease risk; therefor increasing wellbeing (Iwata 2018).

Oats are functional foods due to be a good source of beta–glucan, essential amino acids, antioxidants and other essential nutrients important to human health. Recent studies suggest that beta–glucans from oats and oat-based products play a vital role in human physiological processes such as moderating the effect of hypertension, regulating blood glucose as well as insulin levels, weight managements and promoting digestive and gut health (Varma et al 2016).

For each functional food claim added value can be attributed by an estimated of 9% for one, 2 functionalities can add 16% and 3 or more functionalities can added up to 20% (Kantar 2019).

PROBIOTICS

Cereals are one of the most suitable and recognised substrates for prebiotic containing product development. It is also consumed at a time of day where the delivery of prebiotics sees the most benefit (Li et al 2015).

Oats have prebiotic properties due to the presence of non-digestible components making the perfect environment for the growth of healthy gut bacteria. Prebiotics are non-digestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon thus improving overall health. Oats are found to be the good substrates for the growth of probiotic microorganisms due to the presence of non-digestible components beta–glucan which serves as a prebiotic. This is due to beta-glucans being indigestible in the small intestines and are fermented by intestinal microflora in the colon that stimulates the growth of beneficial gut microorganisms. Gut microflora has been connected with positive influences on physical and mental health (Lawrence and Hyde 2015).

Prebiotics are being added to the food products to stimulate the gut microflora to gain the health benefits to the consumers, besides providing textural attributes to the foods.

CHOLESTEROL AND OATS

One component of the soluble fibre found in oats is beta-glucan, which has proven to be effective at lowering blood cholesterol. Consumption of oat beta-glucans may reduce total blood concentrations of low-density lipoprotein (LDL). Oat soluble fibre beta-glucan break down as it passes through the digestive tract, forming a gel-like structure that traps some substances related to cholesterol-rich bile acids. This entrapment reduces the absorption of cholesterol into the blood stream (Sima et al 2018).

Oats grains are also one of the best sources of compounds called tocotrienols (Boeck 2018). Tocotrienols are antioxidants which together with tocopherols form vitamin E. These tocotrienols inhibits the cholesterol synthesis and have found in lowering the blood cholesterol (Ramanathan 2018). The accumulation of cholesterol is implicated in many types of cardiovascular disease.

Recent research has also discovered that the antioxidants found in oats reduce cholesterol by reducing the ability of blood cells to stick to the inside of artery walls (Hassain et al 2018).

DIABETES AND OATS

Oat beta-glucan has beneficial effects in diabetes or blood sugar (Wang and Lui 2019). Oat fibre rich foods have shown to create much lower rises in blood sugar compared to food without oat fibre. Thus, eating oats can aid the control of blood sugars over a longer period of time (Gubler 2019). It is essential to control blood glucose and insulin levels to prevent many of the additional health risks associated with diabetes (American Diabetes Association 2019).

The low glycaemic index of oat products is especially important for diabetes and the ingestion of beta-glucan containing foods is reported to affect the level of fat removal in the gastrointestinal tract and reduces lipase activity (Lovegrove 2015).

HYPERTENSION & OATS

Consumption of oat soluble fibre can reduce hypertension and so reduce the need of medication in most lifestyle induced symptoms (Earnshaw 2017). Oats may help maintain healthy blood pressure by improving the glycaemic and insulinemic profiles (Khan et al 2018). Soluble fibre-rich whole oats may be an effective dietary therapy in the prevention and treatment of hypertension (Slurink 2016).

GASTROINTESTINAL TRACT (G.I.T) HEALTH

Oats are rich in dietary fibre and these fibres are necessary in keeping bowel movements regular. Oats are high in both soluble and insoluble fibre. The insoluble fibres do not dissolve in water but are spongy and absorb many times their own weight of liquid. These insoluble fibre makes stools heavier and increase motility through the gut, relieving constipation (Capasso 2015).

WEIGHT MANAGEMENT

The gelatinous form from soluble fibre in oats delays stomach emptying making you feel full longer aiding satiety and can help with weight management (Brownlee 2018). When the desire for food intake is reduced, it helps in the control of weight management when consumed with a healthy, balanced diet and adequate exercise. It has been reported that the children who eat oatmeal are 50% less likely to become overweight, when compared to those children that did not eat it (O'Neil 2015).

HEALTHY AGING

Oats have a higher concentration of well-balanced protein than other cereals, it also contains a good balance of essential fatty acids, which have been linked with longevity and general good health (Kumaris 2019). Oats contain phytochemicals which have been associated with protection from chronic disease such as cancer (McGuire 2011). Oats also contains the best amino acid profiles of any grain; these amino acids are essential proteins that helps in facilitating optimum functioning of the body (Klose and Arendt 2012). Oat beta-glucan also appears to help speed up immune response against infection, which may result in faster healing (Swarmi 2011).

ACCREDITED CLAIMS

Within the European Union (EU), a regulation on nutrition and health claims came into force in 2007. Under the regulation, health claims are subject to pre-approval, involving scientific assessment by the European Food Safety Authority (EFSA). However, although EFSA assesses the scientific dossiers supporting potential health claims, the final decision to accept or reject a claim lies with the European Commission (EC). The regulation on nutrition and health claims aims to ensure that claims are appropriate, scientifically verified and harmonised across the European Union.

Functional foods have additional health benefits added so, in practice, they are likely to carry an approved nutrition or health claim. An example of a health claim is "vitamin D is essential for the bone growth of children". The list of approved health claims for use on foods and drinks are published in batches and can be assessed by all on the EFSA website.

Nutrition claims are defined in the Regulation on Nutrition and Health Claims (2006), which states the EC's decision on the specific wording of permitted claims and when they can be used. For example, a food may only claim to be "low fat" if it contains less than 3g of fat per 100g (for solid food products) or less than 1.5g of fat per 100ml (for liquid products).

The European Food Safety Authority (EFSA) approved the health claim that beta-glucans within oats have health enhancing properties. Linking that by consuming 3g of oats per day can reduce cholesterol levels gaining an Article 13 and 14 approved claims.

"General function" claims under Article 13.1 of the EC Regulation on nutrition and health claims refer to the role of a nutrient or substance in growth, development and body functions; psychological and behavioural functions; slimming and weight control, satiety or reduction of available energy from the diet. These claims do not include those related to child development or health or disease risk reduction.

Claims under Article 14 of the EC Regulation on nutrition and health claims refer to the reduction of disease risk or to children's development or health.

Approved claims for oats;

- Scientific Opinion on the substantiation of a health claim related to oat beta glucan and lowering blood cholesterol and reduced risk of (coronary) heart disease pursuant to Article 14 of Regulation (EC) No 1924/2006
- Scientific Opinion on the substantiation of health claims related to beta-glucans from oats and barley and maintenance of normal blood LDL-cholesterol concentrations (ID 1236, 1299), increase in satiety leading to a reduction in energy intake (ID 851, 852), reduction of post-prandial glycaemic responses (ID 821, 824), and "digestive function" (ID 850) pursuant to Article 13(1) of Regulation (EC) No 1924/2006

Table 4; Beta glucan claim and usage (EFSA 2019)

| Nutrient | Claim | Conditions of use |
|--|--|--|
| Beta Glucans from oats and barley | Consumption of beta glucan from oats or barley contribute to the reduction of the blood glucose post prandial. | Products must contain more than or equal to 4g of beta glucan |
| Oat beta glucan | Oat beta glucan lowers/reduce blood serum cholesterol. High cholesterol is a risk factor of CHD | More than or equal to 1g of oat beta glucan per portion *daily intake of 3g beta glucan is recommended to gain full benefit |
| Oat grain fibre | Oat grain fibre contributes to an increase in faecal bulk | More than or equal to 6g fibre per 100g |

BETA-GLUCANS AND WIDER MARKET

The use of beta-glucan to reduce post-prandial glucose is likely to be of benefit to a much wider range of consumers than originally identified by the EFSA. For example, many athletes look for snacks where there is prolonged release of glucose and the avoidance of large fluctuations in blood glucose products. While diabetic organisations do not favour the use of special diabetic products, they too could welcome the provision of snack foods with lower glycaemic index and more prolonged availability of glucose.

The general UK population fails to consume adequate amounts of fibre in the diet (DNS 2017). The high content of soluble fibre in oats make oats an attractive way of including additional fibre in the diet and there is always a shortage of high fibre foods for health snacking opportunities. The use of rolled oats in cereal bars could provide the basis of healthier snacks for the future and can build on the many varieties of bars already available; it also seems likely that the growth in breakfast cereal bars and drinks will continue and this offers scope for more beta-glucan-based products.

MARKET FOR OAT-BASED SNACKING & DRINKS

This shift to accessing affordable healthy food to support active lifestyles is a major cause of the growth in popularity of the oat-based snacks and drinks. In addition to the significant nutritional value of oats, the increasing popularity of oat-based snacks and beverages may also be due to products changing marketing strategy. Oat-based snacks are increasingly being marketed in ways that appeal to millennials advertised via digital marketing in an effective way, ensuing that millennials are informed about the nutritional attributes of oat-based products (NutraIngredients 2019).

Though the benefits of eating oats can be gained by eating traditional porridge oats, it's not the most popular oat-based food on the market. Oat-based bakery items and bars make up more than 76% of the total oat-based snacks market (Zion 2019). Market research suggests that this is largely due to millennials not having time to prepare traditional oat cereal or other types of breakfast in the morning and are instead choosing to have breakfast on-the-go, healthy bars and other items as a meal substitute.

Oat-based bars, especially protein enhanced oat bars, are popular as post exercise snacks with fitness-minded millennials and a healthy swap with traditional midmorning or afternoon snacking options. Gluten-free oat-based products, as well as oat-based savoury snacks, cookies, cakes, and cereals are also expected to see increased and widespread popularity as the global oat-based snacks market continues to grow (Lumina 2019).

Oat milk is a relatively new, yet well received beverage base, additive and milk substitute. The use of oat-based milk substitute sits well within the plant-based movement. Due to the creamy texture and mild flavour oat milks have become an increasingly demanded beverage.

OAT BREEDING AND VARIETIES

Winter oats are most suited to Welsh low lands and provide a higher yield than that of spring crop varieties. Oats are a low input crop cereal break crop. Oats can aid in the reduction of soil-borne disease and provides to reduce the farm's environmental footprint.

Field selection is of prime importance with the management of weeds such as black-grass, ryegrass, brome and wild oats presenting the biggest challenge to oat crop growing. The use of herbicides in oat weed management hasn't proved overly successful. Therefore, the avoidance of fields hosting such weeds is recommended and if avoidance isn't possible the need to use control methods are essential (Senova 2019).

The oat breeding team at IBERS at Aberystwyth University has been responsible for the development of 30 new varieties since 2001, including those with recognised health and nutritional properties, as well as some with specific characters for specialist high value markets. IBERS's Seed breeding team.

Currently, due to demand, the most popular winter oat variety is Mascani. Although more recent breeds offer slightly higher yields, Mascani has a high kernel content and specific weight desired by the millers, as well as some of the best disease resistance (Senova 2019).

COMPARISON OF HUSKED AND NAKED OATS

A research study investigating the nutritional differences in husked and naked oats designed by *State Stende Cereal Breeding Institute, Latvia*, discovered that both varieties were rich in biologically significant substances. Amino acid composition of husked oats and naked oats varieties were close to optimal. Both evaluated as 'high' for fibre content. However, the naked oats did hold higher composition of protein, fat, fibres, vitamin E and beta-glucans and husked oats containing higher contents of carbohydrates. Both show benefitting nutrient values to human health.

Table 5; Composition of husked and naked oats

| NUTRITENT COMPONENT | Average value of Husked Oats | Average value of Naked Oats |
|---------------------|------------------------------|-----------------------------|
| Protein content | 10.58 | 15.71 |
| Fat content | 5.15 | 9.66 |
| Carbohydrates | 48.08 | 31.55 |
| Vitamin E | 7.80 | 9.5 |
| Total fibre | 17.63 | 22.97 |
| Soluble fibre | 14.32 | 17.63 |
| Beta glucan | 3.15 | 3.29 |

SUMMARY

Due to the increasing demand of healthy snacking and the understanding of oats nutritional attributes it is projected that the market for oats is one that is continuing to grow and gain great consumer following. The appetite for new and exciting products, tastes and eating experiences along with the increased demand for clean, recognisable food ingredients all hold well for the oat market. Alongside whole foods, oats are also well placed to meet the trend for

plant-based milk alternatives and powdered meal replacements, to create nutritious, convenient and tasty on-the-go functional foods.