Scientific Advisory Committee on Nutrition

STATEMENT ON DIETARY FIBRE

August 2008

1. Draft SACN statement on dietary fibre and health and the dietary fibre definition

1.1 Current definitions

1. The current UK definition of dietary fibre (Department of Health 1991) is that dietary fibre should be defined as non starch polysaccharides (NSP) where this refers to non alpha-glucans as measured by the technique of Englyst and Cummings or other comparable techniques.

2. In 1997 the Committee for the Medical Aspects of Food Policy (COMA) subgroup on Dietary Fibre for Labelling purposes were unable to reach a consensus on a definition of dietary fibre for nutrition labelling purposes.

1.2 SACN statement on the definition for dietary fibre

3. SACN have reviewed the available scientific evidence for components under consideration for inclusion in the Codex definition on dietary fibre for nutrition labelling purposes, using the SACN frame work for assessing evidence (SACN 2002). These components include total fibre, non starch polysaccharides, fibre components from cereal, fibre components from fruit and vegetables, starch, resistant starch, polydextrose, oligosaccharides (including fructooligosaccharides (FOS), galactooligosaccharides (GOS) and inulin), lignin, soluble fibres (including pectin and guar gum).

4. There is some evidence to show that 'dietary fibre' (in the form of NSP) as an integral part of a balanced diet, high in food sources such as fruit and vegetables and cereals, appears to have positive effects on health. There are two potential explanations for this observation; firstly dietary fibre could be a surrogate marker for another component of the diet or, secondly, it could be that dietary fibre itself is having a direct effect.

5. Dietary components extracted from foods or synthesised chemically need to show clear evidence of a physiological effect before they can be assumed to be as effective as whole foods intrinsically containing fibres. It still needs to be proven that specific fibres components such as oligosaccharides have an independent effect, The working group

therefore consider that it is potentially misleading to include non intrinsic fibre in the definition in the absence of other evidence.

6. SACN consider that a material can be considered as dietary fibre if it is resistant to digestion and absorption in the small intestine and has a demonstrable physiological effect potentially associated with health benefits in the body, such as increasing stool bulk, decreasing intestinal transit time or decreasing post prandial glycaemia. Evidence only of increased fermentation in the gut should not be included under this definition, since although this has a direct effect on the microflora, it must also be shown to have a demonstrable benefit to the host to be considered as dietary fibre.

7. Based on the available evidence SACN conclude that there is sufficient evidence for an association between those compounds identified as NSP and colonic function (including stool weight/mass and transit time) and between those compounds identified as soluble fibre (from oats, psyllium, pectin and guar gum) and lowering of total cholesterol and LDL cholesterol. The committee note that there is insufficient evidence for health effects in relation to dietary fibre and colorectal cancer or colorectal adenoma, obesity, diabetes, blood pressure lowering and for prebiotic effects.

8. Taking the definition recommended by SACN these two fractions (NSP and soluble fibre) would be the only components definitely included within a fibre definition without further evidence. For other components to be considered for inclusion in the definition the proposed physiological effects need to be demonstrated.

2. Summary of evidence considered by SACN on fibre and health

9. A summary of the evidence considered by SACN and the conclusions drawn are presented below. A full review of this evidence will be included in a report on carbohydrate and health, which will be published when the committee have finished their deliberations.

2.1 Obesity and metabolic health

2.1.1 Observational studies

10. On balance, evidence from observational studies is suggestive that increasing amounts of total fibre (as determined by AOAC method) in the diet are associated with lower body weight and waist circumference. The single study (Iqbal et al 2006) to find no association investigated a smaller sample than the majority of studies where a positive association was seen. There is no evidence for an association of fibre intake on weight change in children.

11. Evidence from 12 prospective studies investigating total fibre intake and type 2 diabetes incidences is variable (Colditz *et al* 1992; Hodge *et al* 2004; Hu *et al* 2001; Krishnan *et al* 2007; Lindstrom *et al* 2006a; Lindstrom *et al* 2006b; Meyer *et al* 2000; Montonen *et al* 2003; Salmeron *et al* 1997a; Salmeron *et al* 1997b; Schulze *et al* 2004; Schulze *et al* 2007; Stevens et *al* 2002). The majority of studies have not seen any significant association of fibre with risk of diabetes. A number of the studies have investigated relationships with different sources of fibre. There is evidence of an association with

cereal fibre intake, with nine of eleven studies observing a significant reduction in diabetes incidence with increasing intake.

12. The totality of the evidence does not support an association for fibre from fruit, vegetables or legumes on the outcomes investigated. Two of three studies observed an association with insoluble fibre intakes, but no association with soluble fibre (Meyer *et al* 2000; Montonen *et al* 2003).

13. Amongst cross-sectional studies investigating the association of metabolic risk factors with fibre intake, a decreased risk of metabolic syndrome has been observed with increased cereal fibre intake, but not with total, fruit, vegetable or legume fibre (Mckeown *et al* 2004; Newby *et al* 2007). This is consistent with the evidence discussed for diabetes risk. Studies have investigated the relationship between fibre intake and a variety of measures of insulin sensitivity and glucose tolerance. Although not wholly consistent, these are suggestive of an association, particularly for total and cereal fibre.

2.1.2 Intervention Studies

14. Intervention studies have investigated the relationship between non-starch polysaccharide and food sources of fibre on weight and insulin sensitivity/ glucose tolerance [1]. The balance of evidence suggests that fibre supplementation with certain fibres in sufficient amounts is more likely to be efficacious in assisting weight loss as an adjunct to a weight-reducing diet than an *ad libitum* habitual diet. There is no evidence to suggest an association of fibre supplementation on weight control in children, which is consistent with evidence from observational studies.

15. In terms of insulin sensitivity/ glucose tolerance, studies have tended to show beneficial effects of supplementation when more sensitive measures, such as the euglycaemic hyperinsulinaemic clamp, have been used with fewer benefits seen in those using fasting measures. However, health benefits have only generally been observed in subjects at higher metabolic risk, with very little evidence to suggest that insulin sensitivity or glucose tolerance can be further improved in healthy subjects. A wide range of supplements have been used in these studies, with few direct comparisons between types of fibre, making it difficult to draw conclusions about differential health benefits.

16. Only a small number of studies have investigated the effects of isolated oligosaccharides (Abrams *et al* 2007; Brighenti *et al* 1999; Cani *et al* 2006; Castiglia-Delavaud *et al* 1998; Daubioul *et al* 2005; Ellegard *et al* 1997; Giacco *et a*l 2004; Jackson *et al* 1999; Luo *et al* 1996; Schaafsma *et al* 1998; Whelan *et al* 2006), resistant starch (Noakes *et al* 1996; Park *et al* 2004; de Roos *et al* 1995; Robertson *et al* 2005) or polydextrose (Schwab *et al* 2006). None have used lignin in isolation. Studies suggest that resistant starch has a positive effect on insulin sensitivity and glucose tolerance, however, further research is required to confirm this relationship. There is no consistent evidence to support an association with weight change or maintenance of body weight in either lean or overweight subjects. There is insufficient evidence to show an association between oligosaccharides, inulin, or polydextrose on weight outcomes or metabolic profiles.

[1] Intervention studies investigating weight and metabolic outcomes are listed within the reference section.

2.2 Cardiovascular disease

17. Studies investigating fibre and cardiovascular disease have either focussed on its effect on lipids or disease endpoints such as myocardial infarction, coronary heart disease, stroke and death.

2.2.1 Observational studies

18. The cross-sectional McKeown et al 2002; Newby et al 2007; Lairon et al 2005; Ylonen et al 2003) and prospective studies (Ludwig et al 1999; Pietinen et al 1996; Wolk et al 1999; Liu et al 2000; Liu et al 2002; Jensen et al 2004) are inconclusive in their findings on the relationship between dietary fibre and risk of cardiovascular disease. Where an inverse association has been observed, it is often the association with the whole grains which have been studied. Very few studies have investigated whether there is an association with actual cardiovascular disease events. In terms of lowering cholesterol the findings are inconsistent, thus making it difficult to draw any firm conclusions.

2.2.2 Intervention Studies

19. Intervention studies (67 studies summarised in a meta-analysis by Brown et al 1999) have looked at the consequences of different types of fibre on lipid profiles. The types of fibre material studied include; oats, psyllium, pectin, barley, wheat, fibre supplements, legumes, isolated polysaccharides (Konjac-mannan, arabinogalactan, arabinoxylan, carob pulp, guar gum and hydroxypropylmethylcellulose), resistant starch and oligosaccharides and inulin. A meta analysis of intervention studies and trials subsequent to this have been considered. Overall, they suggest that soluble fibre, in particular that from oats, psyllium, pectin and guar gum may be effective in lowering total cholesterol and LDL-C when these fibres are present in the appropriate form and quantity.

20. Three intervention studies (Behall et al 2004a; Behall et al 2004b; Keenan et al 2007) that investigated barley products were identified, these suggested that fibre from this source could be effective in lowering total and LDL-C concentrations in hypercholesterolemic subjects.

21. Resistant starch does not demonstrate a cholesterol lowering effect (Heijnen et al 1996; Noakes et al 1996) and thus, based on this criterion it is not suitable to be considered a dietary fibre. There is not enough evidence to suggest that fibre from wheat, isolated polysaccharides, fibre supplement mixtures and non-digestible oligosaccharides (Arvill et al 1995; Blake et al 1997; Maki et al 2000;Vuksan et al 2000; Davidson et al 1998; Jackson et al 1999; Causey et al 2000; Luo et al 1996; Pedersen et al 1997; Schaafsma et al 1998; Brighenti et al 1999; van Dokkum et al 1999; Kruse et al 1999; Letexier et al 2003) lower cholesterol levels. In terms of legumes, three out of the four studies (Cobiac et al 1990; Fruhbeck et al 1997; Pittaway et al 2006; Anderson et al 1990) suggested that fibre from this source may have a cholesterol lowering effect, however the studies have serious flaws in study design, thus making it difficult to confirm any associations observed.

22. In terms of blood pressure, there is insufficient evidence, both from observational (Lairon et al 2005; Ascherio et al 1996) and intervention studies (24 trials included in meta

analysis by Streppel et al 2005), to demonstrate that dietary fibre has any effect on this outcome.

2.3 Colorectal cancer

2.3.1 Prospective studies

23. Cohort studies on dietary fibre and colorectal cancer generally focus on total fibre as determined by the AOAC method which does not allow separation into the different components. Therefore the individual fibre components contained in this AOAC defined fibre cannot be directly associated with risk of colorectal cancer.

24. All but one cohort study (Pietinen *et al* 1999 who used the Englyst method) assessed AOAC defined dietary fibre. In addition the length of follow up varied.

25. The evidence is variable with eight out of 17 cohort studies finding no statistically significant association between AOAC determined dietary fibre and colorectal cancer[2]. In several studies (Willett *et al* 1990; Giovannucci *et al* 1994; Michels *et al* 2005; Schatzkin *et al* 2007; Nomura *et al* 2007) where an association was initially observed this disappeared when the studies were adjusted for multiple confounding factors. There are no reliable biomarkers of fibre intake, and it is possible that measurement error in dietary assessment leading to misclassification of exposure may have affected the results of the observational studies.

26. Ten studies have investigated the link between fruit, vegetable and grain sources of fibre and colorectal cancer (Fuchs *et al* 1999; Giovannucci *et al* 1994; Lin *et al* 2005; Mai *et al* 2003; Michels *et al* 2005; Bingham *et al* 2003; Bingham *et al* 2005;Nomura *et al* 2007; Schatzkin *et al* 2007; Terry *et al* 2001; Wakai *et al* 2007; Willett *et al.,* 1990). Whilst studies on fibre from fruit or grain generally suggest a protective effect, studies on vegetable fibre and colorectal cancer are inconclusive.

27. Three studies have distinguished between fibre from fruit, vegetable and grain sources and risk of colorectal adenoma (Giovannucci et al 1992; Jacobs et al 2002; Platz et al 1997), while these suggest a protective effect for fruit fibre the results for vegetable and grain fibre were inconclusive .

2.3.2 Intervention studies

28. Two RCTs (The Wheat Bran Fibre Trial (WBFT) and European Cancer Prevention Organisation Intervention Study (ECPOIS)) looked at fibre and colorectal adenoma reoccurrence (Alberts *et al* 2000; Bonithon-Kopp *et al* 2000). These both investigated wheat bran and psyllium supplements respectively. These RCTs showed either no evidence of effect when using wheat bran fibre or evidence of increased risk when using psyllium. However, the WBFT did not reach statistical significance and the ECPOIS was stopped early for financial reasons. Therefore there is insufficient evidence from trials for any of the potential dietary fibre components.

[2] Cohort studies investigating colorectal cancer and fibre, as measured by the AOAC method, are listed within the reference section.

2.3.3 Summary of evidence from observational and intervention studies from WCRF report

29. The working group note that the World Cancer Research Fund expert panel (WCRF 2007) were unable to draw a firm conclusion on foods containing dietary fibre (which was defined as including both foods naturally containing ‘fibre’ and foods which have had ‘fibre’ added). This was despite an apparent dose-response relationship based on cohort studies and evidence for a plausible mechanism because residual confounding could not be excluded.

2.4 Colonic function

2.4.1 Observational studies

30. Colonic function as determined by faecal weight has been demonstrated to relate to NSP intake (Davies et al 1986; Cummings et al 1992; Birkett et al 1997) but not intakes of starch or resistant starch. In particular, studies on inulin and oligosaccharides show very little effect on faecal output.

2.4.2 Intervention studies

31. Overall oligosaccharides (Alles et al 1999; Bouhnik et al 2007; Brighenti et al 1999;; Chen et al 2001;Molis et al 1996; Ten Bruggencate 2006) and inulin (Causey et al 2000; Den Hond et al 2000; Sairanen et al 2007) have very little effect on faecal weight when these materials are fed and hence an effect on faecal weight is not a criterion that is satisfied by these materials to enable them to be considered dietary fibre.

32. Overall resistant starch has a significant but modest effect on faecal weight (Jenkins et al 1998; Behall et al 2002; Muir et al 2004; Grubbens et al 2001) and this could not be considered of a size which would make it suitable to be considered dietary fibre according to this criterion.

33. The mean increase in daily faecal weight was greater for components such as wheat bran (5.4g/g) followed by fruit and vegetables (4.1g/g) and gums such as psyllium (4g/g) and least for soya products (2.5g/g) and pectin (1.2g/g) (Cummings 2001). It should be noted that many of these studies were only on a small number of subjects and were insufficiently powered

2.5 Prebiotics

34. It has been suggested that non digestible oligosaccharides such as fructooligosaccharides (FOS) , gluco-oligosaccharides (GOS) and lactulose affect the pattern of bacteria making up the gut microflora, but as yet there is no convincing evidence that as potential fibre components they confer any specific health benefit (Bouhnik et al 1996; . Bouhnik et al 1999; Bouhnik et al 2007; Gibson et al 1995; Guigoz et al 2002; Depeint et al 2008; Ito et al 1990; Ito et al 1993; Tanaka et al 1983; Tuohy et al 2002; Ballongue et al 1997).

35. Studies investigating prebiotics were of short durations (often days or weeks) and on a very small number of human subjects. The working group concluded that there was insufficient evidence from good quality human intervention studies to demonstrate that prebiotics have any health benefits which relate to their proposed actions as fibre.

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Annex 1: Carbohydrate definitions relating to fibre

Oligosaccharides- short chain carbohydrates comprising of 3-9 monomers joined together by glycosidic linkages.

Alpha glucans- oligosaccharides with an alpha linkage between monomers

Inulin, Fructooligosaccharides (FOS)- non- α- glucan oligosaccharides, known as fructans, and are the storage component of artichokes and chicory.

Polydextrose -non- α–glucan oligosaccharide

Galactooligosaccharides (GOS)- oligosaccharides found in milk, which principally contain galactose.

Non starch polysaccharide (NSP)- non- α -glucan polysaccharides that are mainly found in the plant cell walls. This includes cellulose, hemicellulose, pectin, arabinoxylans, plant gums, ß-glucans.

Pectin- an NSP which is common to all cell walls.

Guar gum- an NSP which is which is chemically related to the cell wall, but is not strictly a cell wall component. Plant gums are sticky exudates which are formed at the site of injury.

Starch- the storage carbohydrate of plants, such as cereals, root vegetables and legumes, and consists of only glucose molecules.

Soluble fibre- relates to NSP components which can be rendered soluble by changing the pH conditions. These generally undergo significant fermentation, and viscous forms of these may also slow rates of glucose and lipid absorption from the small intestine[A]. Examples of soluble fibres include pectin, beta-glucan (from oats and barley) and psyllium.

Insoluble fibre- NSP components that tend to undergo slow and incomplete fermentation and can have a greater effect on bowel habit[A]. Insoluble fibres are found in vegetables and wholegrain products.

Resistant starch- the sum of starch and products of starch digestion (such as maltose, maltotriose and α-limit dextrins) that are not absorbed by the small bowel.

Prebiotic- a non-digestible food component that stimulates the growth and/ or activity of the bacteria in the bowel.

Lignin- non-carbohydrate component associated with plant walls

Englyst method- specifically determines NSP using an enzymatic-chemical method, which can be modified to yield soluble and insoluble fractions.

American Association of Analytical Chemists (AOAC)/ enzymatic-gravimetric method-

Determines total, soluble and insoluble residue containing carbohydrate and non-carbohydrate material in unknown proportions by measuring total residue weight and subtracting ash and protein content.

[A]The division between soluble and insoluble fibre is extremely pH dependent. Also, a large proportion of insoluble fibres are completely fermented and not all soluble fibre have effects on glucose and lipid absorption. Therefore, WHO have considered these definitions to be less useful when characterising fibre components.