WHAT IS A HIGH FIBER DIET?

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1. ABSTRACT

There is no recognized definition of what constitutes a high fiber diet. Intakes of dietary fiber in different populations internationally vary widely from less than 20g to more than 80g per day. The types of foods contributing fiber also vary; in some countries cereals contribute the most fiber, in others leafy or root vegetables predominate. Vegetables have the highest fiber content per Kcal, and in most populations with fiber intakes over 50g, vegetables contribute over 50% of total fiber intake. In rural Uganda, where the fiber hypothesis was first developed by Burkitt and Trowell, vegetables contribute over 90% of fiber intake. An experimental diet, the "Simian" diet, has been developed to mimic as closely as possible using human foods, the diet consumed by our simian ancestors the great apes. It is also similar to the Ugandan diet in containing large amounts of vegetables and 50g fiber/1000Kcal. Though nutritionally adequate, this diet is very bulky and not a suitable model for general recommendations. Dietary guidelines are that fat intake should be <30% of energy, with a fiber intake of 20–35g/d. These recommendations are inconsistent with a high fiber diet because, for people consuming more than about 2400Kcal, low fiber choices for fruits and grains must be selected to keep dietary fiber intake within the range of 20–35g. In a 30% fat, 1800Kcal omnivorous diet, selection of wholemeal bread and whole fruit, results in a fiber intake over 35g/d, and for an 1800Kcal vegetarian diet, with substitution of modest amounts of peanut butter and beans for meats, dietary fiber intake goes up to 45g/d. Thus, if it is desirable to promote the use of unrefined foods, the recommended dietary fiber intake should be a minimum of 15–20g/1000Kcal.

2. INTRODUCTION

There is no definition of what constitutes a high fiber diet. Current dietary guidelines for Americans recommend a high carbohydrate diet which is rich in fruits, vegetable and whole grain cereals[1]. This advice is given in order to increase complex carbohydrate and die-

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tary fiber intakes. However, there is no definition of how much more fiber should be eaten, and no indication of a minimum or optimal range of fiber intake. A number of agencies, however, have given recommendations for fiber intake: the National Cancer Institute recommends 20–30g/d with an upper limit of 35g [2]. The American Dietetic Association[3] and the American Diabetes Association [4] both suggest that dietary fiber intake should be 20–35g/d.

The position taken in this paper is that a high fiber diet is beneficial for health, and that to achieve higher fiber intakes it is important to provide a specific recommendation for fiber intake. The desirable range of fiber intake suggested by some agencies, 20–35g/d, with an upper limit of 35g/d does not represent a high fiber diet, and, indeed, is inconsistent with the general aim of reducing fat and increasing carbohydrate intakes. To determine how much fiber should be consumed in a high fiber diet, and from what sources, fiber intakes in different populations throughout the world and in various experimental diets will be considered. Finally, dietary recommendations will be used to create sample diets to determine how much fiber such diets might contain.

3. FIBER INTAKES IN DIFFERENT POPULATIONS

Figure 1 shows some examples of fiber intakes in different populations around the world. The data for this figure represent actual intakes (rather than disappearance) and were drawn largely from a review by Bingham[5], supplemented with data from Australia[6], France[7] and Italy[8]. It can be seen that fiber intakes differ considerably not only in the

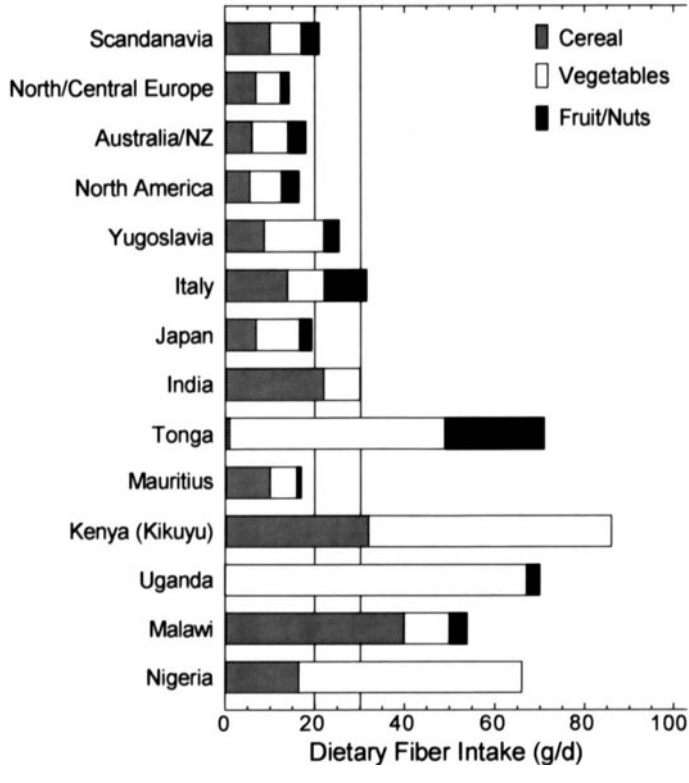

Figure 1. Dietary fiber intakes in different populations.[5-8]

amount, but also in the source of fiber. Bingham points out that previous data for Uganda and Kenya (the Kikuyu) showing fiber intakes of 130–150g/d were based on analyses in which the fiber was likely contaminated with starch, and, thus, the values were too high. She, therefore, revised the values based on more recent analyses. Nevertheless, the intakes in these populations of 70–90g/d is still 3–4 times more than consumed in North America and most other Western countries.

This highlights the fact that there is disagreement about the definition of dietary fiber, and the most appropriate method for measuring it. Until agreement can be reached, it will be difficult to know exactly how much fiber is being consumed and how much should be recommended. Different analytic techniques yield different values of fiber for the same food, because each analysis measures different things. Recently, Marlett and Cheung reviewed this issue and provided an interesting comparison of 5 different methods of analysis[9]. Since fiber values in the USDA database are based on the AOAC method[10], fiber values in this paper are based on the AOAC method.

Returning to Figure 1, it can be seen that most populations consume less than 35g of fiber per day, and that high fiber intakes range from 55–90g/d. The pattern of fiber intake also varies widely. In all populations, vegetables and cereals contribute 75% or more of total fiber, with fruit and nuts contributing a relatively small proportion. In most populations with a very high fiber intake, vegetables contribute most dietary fiber, with cereal fiber being very high only in Malawi. It is of interest that Uganda appears to stand out with over 95% of total fiber coming from vegetables. Rural Uganda, of course, was where Burkitt and Trowell made their observations leading to the development of the fiber hypothesis, and many of us may remember that Trowell often commented that the diet in Uganda consisted of very large platefuls of leafy vegetables. The amount of fiber in foods can be expressed in different ways; the usual way is to give the amount per serving. However, it is instructive to consider fiber intake per 100Kcal. Figure 2 shows the fiber content of the foods in the sample diets shown below expressed as grams per serving and grams per 100Kcal. Vegetables stand out as having a rather low fiber content when expressed as grams of fiber per serving, but the highest fiber content when expressed per 100Kcal. Thus, populations which rely on vegetables to provide energy, such as in rural Uganda, consume very large amounts of dietary fiber. What would such a diet look like? Is it possible to consume a diet extremely high in vegetables?

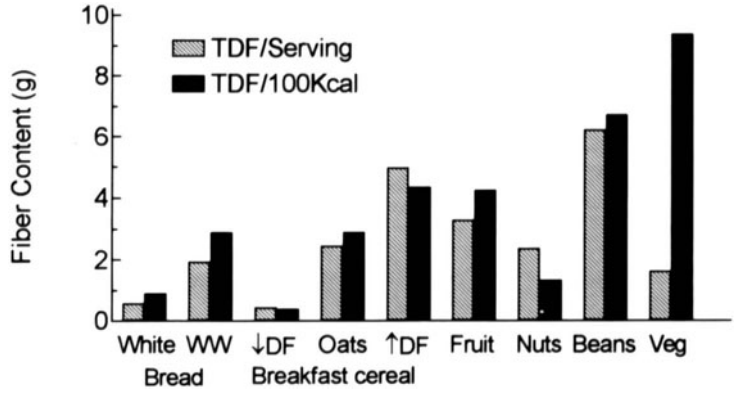

Figure 2. Dietary fiber (TDF) content of the foods used in the sample diets shown in Table 5 and Figure 4 expressed as grams per serving and grams per 100Kcal of food. TDF is according to the AOAC method.[10] WW = wholewheat bread; ↓DF and ↑DF = low and high fiber ready to eat breakfast cereals; Veg=vegetables.

Table 1. Sample 1800Kcal simian diet

Vegetables	2.3kg	Fruit	1.2kg
Cabbage	375g	Banana	225g
Broccoli	375g	Pears	225g
Eggplant	225g	Grapes	240g
Carrots	225g	Mango	248g
Peppers	225g	Blueberries	225g
Tomato	225g	Kiwifruit	75g
Pod peas	225g		
Green peas	188g	Nuts	
Onion	150g	Almonds	74g
Okra	75g		

4. THE SIMIAN DIET

In Toronto, we have been interested in a high vegetable diet because our nearest evolutionary ancestors, the great apes, in the wild, consume a diet which consists predominantly of leaves and shoots. If a simian diet consists of leaves, then, from an evolutionary argument, humans may be most suited to consuming a diet rich in leafy vegetables. Therefore, we have developed diets which are very high in vegetables with virtually no starch (Table 1), and compared their effects, in 2-week feeding trials, with those of consuming what we have called a neolithic diet, which is high in fiber and contains a variety of starchy foods (Table 2). Both of these diets contain 1800Kcal, are low in fat (23% energy) and adequate in protein (66g/d). The simian diet, with 2.3kg vegetables and 1.2kg fruit per day, contains over 90g fiber compared to 47g in the neolithic diet (Figure 3). In addition, the simian diet contains adequate amounts of nutrients (with the exception of vitamin B_{12}). Table 3 shows the calcium, iron, zinc and magnesium content of the simian diet compared to the sample omnivorous and vegetarian diets shown below. The simian diet is not being presented here as a model for general recommendations, but as a sample of an extreme experimental diet which shows that it is possible to consume 90g or more of fiber per day, similar to the diet in rural Uganda.

Table 2. Sample 1800Kcal neolithic diet

Cereals		Fruit	
Oats (raw)	50g	Raisins	38g
WW bread	72g	Dates	27g
Br rice (raw)	72g	Figs	16g
		Pears	119g
Vegetables		Apple	200g
Tomato	89g	Banana	165g
Olives	72g		
Broccoli	90g	Other	
		Yoghurt	129g
Legumes (raw)		Cottage cheese	124g
Chickpeas	22g	Olive oil	23g
Lentils	29g		

WW bread = wholewheat bread; Br rice = brown rice.

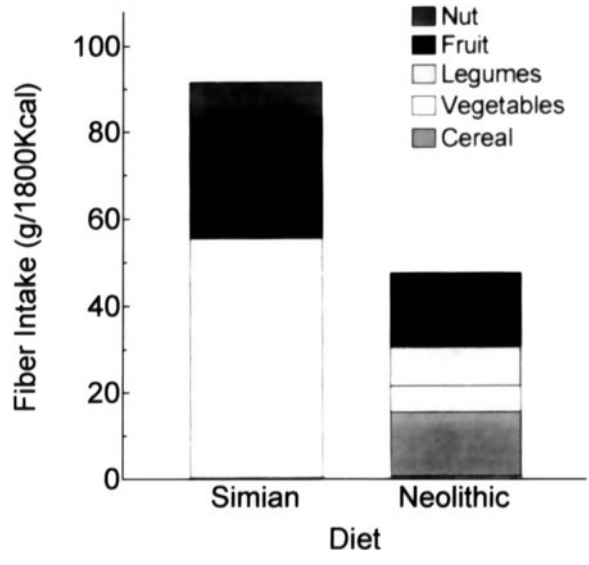

Figure 3. Dietary fiber content (grams/1800Kcal) of the experimental Simian and Neolithic diets shown in Tables 1 and 2.

One of the things Dennis Burkitt was famous for was showing pictures of very large stools passed by rural Ugandans. Preliminary experience with the simian diet shows that it is an extremely potent stool bulking diet. The mean daily stool output of 5 subjects on a simian diet containing an average of 90g fiber per day was over 900g/d. One subject produced over 1.7kg/d of stool. This, then, confirms Burkitt's observations that stools are very bulky on a diet containing very large amounts of vegetables!

5. DIETARY GUIDELINES FOR AMERICANS

Dietary guidelines for Americans are: eat a variety of foods; maintain healthy weight; choose a diet low in fat, saturated fat, and cholesterol; choose a diet with plenty of vegetables, fruits and grain products; use sugars only in moderation; use salt and sodium in moderation; and if alcoholic beverages are drunk, do so in moderation[11]. It is recommended that the diet contain ≤30% energy as fat, and ≤10% saturated fat. To achieve this, the recommendations suggest that most people should have 3–5 servings of vegetables, 2–4 servings of fruits, 6–11 servings of grain products, 2–3 servings of milk products and 2–3 servings of meats and alternates daily (Table 4). With respect to dietary fiber, it is recommended that fiber rich foods be consumed rather than fiber supplements, but no

Table 3. Mineral content of sample 1800Kcal high fiber diets

	Omnivorous	Vegetarian	Simian
Fiber	37 (5)	47	91
Calcium	1117	1280	953
Iron	32 (17)	17	22
Zinc	15 (4)	7	10
Magnesium	274	361	766

Table 4. Dietary guidelines for Americans (USDA, 1990)

Vegetables	3–5 servings*
Fruits	2–4 servings
Breads, cereals, rice, and pasta	6–11 servings
Milk, yogurt, and cheese	2–3 servings
Meats, poultry, fish, dry beans and peas, eggs, and nuts	2–3 servings

*1 serving:
Vegetables: 1c raw leafy or ½c of other kinds
Fruits: 1 med apple, orange or banana; ½c small/diced fruit, ¾c juice
Grains: 1 slice bread; ½ bun/bagel; 1oz RTE cereal; ½c cooked cereal/rice/pasta
Dairy: 1c milk/yogurt; 1½oz cheese
Meats: 2-3oz lean meat; 1egg, ½c cooked legumes, 2tbs peanut butter = 1oz meat

specific amount is provided. Agencies which recommend a range of intake for dietary fiber include the National Cancer Institute[2], the American Dietetic Association[3] and the American Diabetes Association[4]. They all agree that the optimum range of fiber intake should be 20–35g/d. The National Cancer Institute suggests that 35g/d is the maximum safe amount of dietary fiber which should be consumed.

To see a fiber intake of 20–35g/d is compatible with the Dietary Guidelines for Americans, we created sample diets containing the suggested maximum number of servings from the 5 food groups. We found that 5 servings of vegetables, 3 servings of fruit, 11 servings of grain products, 3 servings of dairy and 3 servings of meats yeilded about 1800Kcal and that a small amount of margarine could also be added, while keeping total fat intake within 30% of energy as recommended (Table 5). When low fiber foods were selected, ie. refined grains and fruit juice, the amount of dietary fiber was 15.8g (8.5g/1000Kcal). With selection of lower fiber vegetables, an even lower fiber intake could have been achieved. Nevertheless, if moderately high fiber foods are substituted into this diet, ie. wholewheat bread instead of white bread, a bran muffin for the blueberry muffin, moderately high fiber cereal such as oatmeal or raisin bran instead of cheerios, and 3 servings of whole fruit instead of fruit juice, the fiber content increased to 37g (20g/1000Kcal; Figure 4), which is more than the maximum safe

Table 5. Sample 1800Kcal omnivorous, low fiber diet

Breakfast	Snack
White toast — 2 slices	Blueberry muffin — 1 small
Margarine — 2 tsp	Apple juice — 5 oz
Cheerios — 1 cup	
2% milk — ½ cup	Dinner
Boiled egg — 1	Spaghetti (white) — 1 cup cooked
Orange juice — 7oz	Ground beef — 3 oz
	Carrots — ¼ cup
Lunch	Cauliflower — ¼ cup
White bread — 4 slices	Tomato — ¼ cup
Processed cheese — 4 slices	Broccoli — 1 cup
Ham — 2 slices	2% milk — 1 cup
Lettuce — 4 leaves	
Apple juice — 5 oz	

Vegetables: 5 servings; Fruits: 3 servings; Grains: 11 servings; Dairy: 3 servings; Meats: 3 servings; Kcal: 1850; Fat: 29.5% energy; Pro: 19.9% energy; Carb: 50.6% energy; Fiber: 15.8g

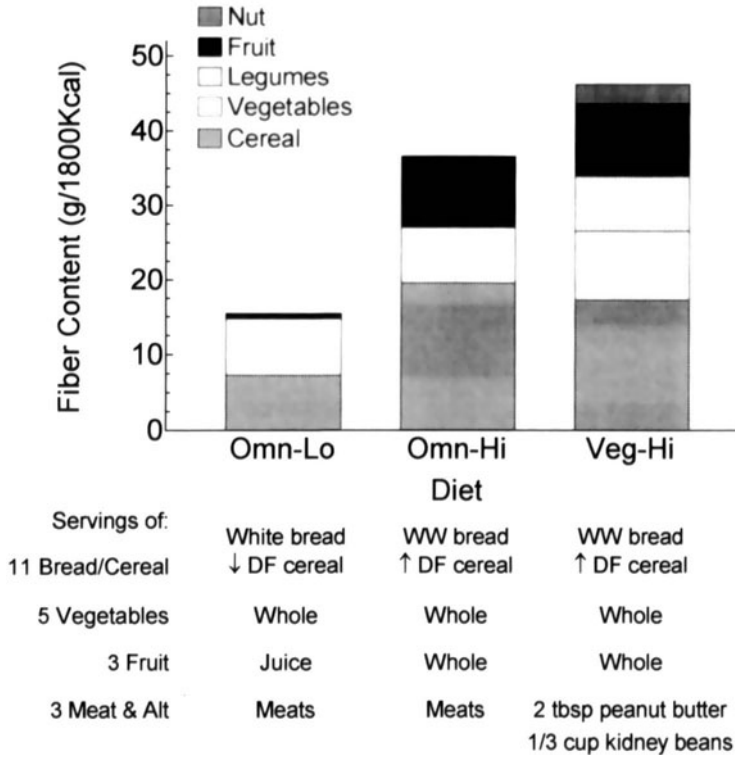

Figure 4. Dietary fiber content (grams/1800Kcal) and number of servings and types of foods in the 4 fiber-containing food groups of sample diets. Omn-Lo = omnivorous, low fiber as shown in Table 5; Omn-Hi = omnivorous, high fiber; Veg-Hi = vegetarian, high fiber. WW = wholewheat bread; ↓DF and ↑DF = low and high fiber. The vegetables are the same in all 3 diets (Table 5) except that in the vegetarian diet a carrot was substituted for the lettuce at lunch. In the 2 high fiber diets, 1 banana, 1 orange and 1 apple were substituted for the apple and orange juice (Table 5). In the high fiber diets, a bran muffin was substituted for the blueberry muffin. The same amount of white spaghetti was used in all 3 sample diets (Table 5).

amount recommended by the National Cancer Institute. If a vegetarian diet is selected, by replacing meats with cheese and a small amount of peanut butter and a small serving of beans, the fiber content of the diet increased to 47g (26g/1000Kcal), 33% higher than the safe maximum. It is easily possible to increase the fiber content of this diet even further by selecting a very high fiber breakfast cereal (such as a wheat bran cereal) and whole wheat pasta and using less cheese and more beans.

It should be emphasized that these sample diets contain only 1850Kcal. This is just under the average energy intake for 16–49 year old females (1890Kcal), but only 64% of the intake of males aged 16–49 years, 2875Kcal[12]. If adult men were to select a low fat diet, according to recommendations, containing 2900Kcal, low fiber foods would have to be selected to keep fiber intake within the range of 20–35g/d. Women, consuming only 1900Kcal, could also have an intake of fiber which exceeds 35g/d if they selected moderately high fiber foods. Thus, the recommendation to eat only 20–35g fiber per day is inconsistent with current dietary recommendations. If a diet is selected which contains 30% of less of energy as fat, it is impossible to eat plenty of vegetables, fruits, wholegrain cereals, breads, dry beans and peas, because low fiber foods must be selected to consume

Table 6. Recommended fiber intake

Minimum desirable:	15–20 g/1000 Kcal
Source:	Emphasis on a variety of foods, especially leafy vegetables, cereals, legumes and fruit.

only 20–35g of dietary fiber. Selection of wholegrain cereals, breads and dry beans, with plenty of vegetables and fruit, as recommended, results in a diet which contains at least 15–20g of fiber per 1000Kcal, and possibly considerably more.

6. CONCLUSION

There is little evidence that individuals consuming balanced diets rich in whole foods, such as vegetarians, have nutritional deficiencies[13–16]. Thus, to be consistent with general dietary recommendations, we suggest that the minimum desirable intake of dietary fiber should be 15–20g/1000Kcal, and the intake could be considerably higher with no deleterious effects. Dietary fiber should be obtained from a variety of foods, especially leafy vegetables, cereals, legumes and fruit.

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