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REFINED CARBOHYDRATES - A CAUSE OF SUBOPTIMAL NUTRIENT INTAKE

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ABSTRACT

During the refining of carbohydrate foods there is a sharp drop in the concentration of dietary fiber and of various vitamins and minerals. Estimates were made of the effect of refining on the total diet intake of fiber, selenium, folic acid, vitamins E and B6, choline, chromium, magnesium, zinc, manganese, copper, sodium and potassium. The health implications of this are discussed and it is concluded that the losses are likely to be detrimental.

INTRODUCTION

Refined carbohydrates (sugar, white flour, white rice, cornflakes, etc.) are a major component of the Western diet. This has came about almost entirely in the last 100 to 150 years. Furthermore, these food items have became a major source of calories for many Third World peoples who, until quite recently, consumed only a traditional diet.

Cleave (1) and Burkitt and Trowell (2) have argued that refined carbohydrates cause a spectrum of diseases, particularly diabetes (adult onset), obesity, coronary heart disease (CHD) and various diseases of the veins, gums, teeth and colon.

In the production of refined carbohydrates, fractions containing much of the vitamin, mineral and fiber content but little of the carbohydrate are removed (3-5). These are generally fed to livestock or, particularly in the last decade, sold through Health Food shops. Thus refining causes a marked fall in the nutrient: calorie ratio in much of our food.

Man is extremely well adapted to the natural environment (gravity, temperature, sunshine, etc). It follows

that the diet for which we are most suited is that taken by our hunter-gatherer forebears during human evolutionary development. Its carbohydrate content would obviously be in the unrefined form.

Perhaps the following indicates the extent of our adaptation to available food. The requirements of various nutrients vary over a range of about ten million from vitamin B12 at one extreme to total protein at the other. Yet for each most people consume between half and twice the recommended intake. It is reasonable to conclude, therefore, that the optimum intake of vitamins and minerals is that present in a diet rich in unrefined carbohydrates and other natural foods. As Masironi (6) put it, "Over hundreds of thousands of years man became adjusted to the mineral balance of the natural environment..... The natural balance is now perhaps being disrupted by man himself, whose organism has not yet had time to adjust biochemically to these rapid, technologically - induced changes".

LOSS OF NUTRIENTS DURING REFINING

In order to calculate the impact of carbohydrate refining on nutrient intake a typical Western diet was formulated with sugar and cereals being present entirely in the refined form. The diet used here is essentially British and is based on The National Food Survey (7). A second diet was derived from this which was as similar as possible except that refined cereals and sugar were replaced with unrefined foods, namely potatoes, apples, bread, unrefined breakfast cereals, peanuts and beans. It is assumed that this would be a typical dietary adaptation if refined carbohydrates were no longer consumed. The data are shown in Table 1.

Due to insufficient information, figures for chromium and selenium are only approximate. Refining causes a loss in the intake of all nutrients under discussion except sodium, the intake of which rises slightly. In some cases the proportion of the ingested nutrient that is absorbed is altered (usually decreased). This needs to be allowed for when assessing the impact of refining.

CORONARY HEART DISEASE

It is argued elsewhere (18) that the consumption of refined carbohydrates may be the prime cause of CHD. This may be partly explained by a relative deficiency of several of the nutrients discussed here. Since bran and wholewheat bread exert little or no hypocholesterolaemic action (19), evidence has not been included of an anti-atherosclerotic effect of a nutrient if this appears to be secondary to a reduction in the blood cholesterol level.

Table 1. Nutrient intake in refined and unrefined diets

Nutrient	Units	Refined diet*	Unrefined diet*	A=Refined x 100 / Unrefined	100-A +	Reference ‡
Fiber	g	25.10	49.80	50.3	49.7	8,9
Selenium	µg	83.80	214.00	39.1	60.9	10
Folic Acid #	µg	189.00	410.00	46.1	53.9	11
Vitamin E ¶	mg	7.21	13.20	54.8	45.2	12,13
Vitamin B6	mg	1.30	2.08	62.5	37.5	
Choline	mg	606.00	859.00	70.5	29.5	
Chromium	µg	99.00	117.00	84.6	15.4	14,15
Magnesium	mg	195.00	550.00	35.5	64.5	
Zinc	mg	14.20	20.60	68.8	31.2	15-17
Manganese	mg	3.51	12.50	28.1	71.9	15
Copper	mg	1.45	2.81	51.6	48.4	17
Sodium	g	4.63	4.13	112.1	-12.1	
Potassium	g	2.68	3.91	68.7	31.3	
Na/K ||	-	1.73	1.06	163.2	-63.2	

*Foods contained in the same quantities in each diet are milk 350 (units are g/day in each case), cheddar cheese 15, stewed beef minced 150, steamed cod 18, boiled eggs 35, margarine 45, Brussels sprouts 34, carrots 55, peas 50, salt 4 and tea (before brewing) 9. The refined diet also contains white bread 127, cornflakes 100, white sugar 111, boiled potatoes 175 and apples 73. The unrefined diet has wholewheat bread 160, Weetabix 130, boiled potatoes 200, apples 110, peanuts 35 and beans 65. Both diet have 2320 kcal.

+The percentage loss of each nutrient due to refining is 100 minus A, where A is the intake in the refined diet as a percentage of the unrefined one.

‡General references used concerning the nutrient content of food are 3-5.

#Folic acid is total.

¶Vitamin E is α-tocopherol equivalent.

||Na/K denotes the sodium: potassium ratio.

FIBER

In the diet used here refining has caused a 50 percent loss of dietary fiber (Table 1). It is largely due to the pioneering investigations of Cleave (1,20) that the role of fiber shortage in a variety of disorders became a subject of serious study. Burkitt, Trowell and others (2) further developed Cleave's hypothesis. Cereal fiber much

increases fecal bulk and consequently shortens the intestinal transit time (21,22). In addition, the softer stool requires much less colonic pressure to expel it (23).

Disorders for which a strong case exists for association them with fiber deficiency are constipation, varicose veins, deep vein thrombosis, hemorrhoids and diverticular disease. Fiber depleted foods facilitate overconsumption of calories and thus partially cause overweight and perhaps adult onset diabetes. The balance of evidence suggests that bowel cancer is caused at least partly by fiber deficiency (24,25) as is pulmonary embolism (23), appendicitis (26) and hiatus hernia (27). Gallstones may also be included. Wheat fiber reduces the lithogenic potential of bile in subjects with gallstones (28,29) or where the bile is supersaturated (30).

SELENIUM

Refining causes, very approximately, a 39 percent decrease in selenium intake (Table 1). Shamberger and coworkers (31,32) have demonstrated a strong negative correlation between the selenium status of human populations and mortality from coronary and hypertensive heart disease and to a lesser extent cerebrovascular disease. They refer to animal experimentation data in support of these observations.

These findings are paralleled with respect to cancer. For several body sites cancer mortality shows an inverse correlation with selenium status (33,34). Similarly, animal experiments show that the mineral has an impressive anticarcinogenic action (35-38). It also reduces mercury induced mortality in Japanese quail chicks (39-41) and rats (40).

FOLIC ACID

Refining reduces the intake of folic acid by about 54 percent (Table 1). Birth defects are associated with folic acid deficiency (42). Laurence et al. (43) studied women who had previously given birth to a baby with a neural tube defect. A supplement of 4mg per day given before and during early pregnancy appeared to prevent recurrence.

In a study of elderly patients with folate deficiency and with apparent degeneration of the spinal cord, folate supplementation reversed the neuropathy (44). Folate deficiency also appears to be associated with mental illness (45).

VITAMIN E

A 45 percent reduction in vitamin E intake is caused by refining (Table 1). Various observations suggest that this

level of loss may be quite detrimental. The effect of very large (pharmacological) doses will not be considered.

Vitamin E supplementation was observed to increase the proportion of mice surviving to 24 months. This appeared due to protection against a debilitating condition early in life and a reduced incidence of fatal tumors late in life (46).

Dayton et al. (47) treated rats with DMBA (a carcinogenic, polycyclic, aromatic hydrocarbon) and added to their diets coconut oil or safflower seed oil. A vitamin E supplement reduced the incidence of mammary tumors but only in rats fed coconut oil. Possibly the safflower seed oil already had sufficient vitamin E. It is significant that Shamberger et al. (48) observed that vitamin E protects against carcinogen induced chromosome breaks.

Vitamin E has been reported to improve the immune response in mice (49), protect against air pollution (50), liver lipid peroxidation (51) and toxicity from lead (52) and mercury (39).

VITAMIN B6

A 37 percent fall in B6 intake results from the refined diet (Table 1). However, the vitamin is five to ten percent less available from wholewheat bread (53). B6 supplementation has been found to relieve depression in women caused by oral contraception (54,55). It may also protect against tooth decay (56).

CHOLINE

Refining has caused a 29 percent loss of this nutrient (Table 1). Phosphatidyl choline has been observed to cure experimental atherosclerosis in miniature pigs (57). Brown et al. (58) reported that rabbits with diet-induced atherosclerosis were partly protected by 75 or 500 mg per day choline chloride and to a lesser extent by 10 or 40 mg per day. However, Kritchevsky et al. (59) were unable to confirm this using a diet supplemented with one percent lecithin. There is little evidence for a curative role for lecithin in human CHD (60) though its preventive potential is unexplored.

CHROMIUM

The loss of chromium due to refining is in the region of 15 percent (Table 1). Chromium is a component of glucose tolerance factor which participates in the hypoglycemic action of insulin (61). Consequently, supplements of the nutrient have been given to persons with diabetes (mainly adult onset). In 40 to 50 percent of cases an improved glucose tolerance has been observed while almost all subjects have shown a normalization (ie reduction) in insulin response (61). Similar results

were recently reported in normal subjects (62,63). Indeed, yeast, probably due to its content of chromium, was successfully used to treat diabetes as long ago as 1853 (64).

Chromium deficiency may also be a factor in CHD. It is highly relevant that both an exaggerated insulin response after an oral glucose load and insulin insensitivity are risk factors of CHD (65-67). Studies in the United States have shown a lower aortic chromium level in those who have died of CHD (15) and a lower serum chromium level in those suffering with the disease (68). Similarly, chromium supplementation has reduced experimental atherosclerosis in the rabbit (69).

Lane (70) has reported that persons suffering from myopia tend to have a low hair chromium level.

MAGNESIUM

Refining causes the loss of 64 percent of magnesium (Table 1). Human studies have assessed the effect on magnesium balance of adding wheat bran or wholewheat bread to the diet. In two such studies most of the extra magnesium was lost in the feces (71,72). However, in a third study there was an appreciable net increase in absorbed magnesium (21). Thus refining causes at least some reduction in absorbed magnesium.

A solid body of evidence associates a magnesium shortfall with CHD (73-77). This is based on epidemiology, clinical studies and animal experimentation. In addition, rat studies suggest that a suboptimal magnesium intake may decrease bone strength (78).

ZINC

About 31 percent less zinc is consumed as a result of refining (Table 1). However, as zinc absorption is much less efficient from wholewheat bread (79,80) the net amount of zinc absorbed may not be appreciably altered.

MANGANESE AND COPPER

The losses are 72 percent for manganese and 49 percent for copper (Table 1). As with magnesium and zinc the net loss is almost certainly much more modest.

In the refined diet two thirds of the manganese was derived from tea (the diet is British). Without tea, therefore, the percent loss would have been much greater (though quantitatively the same).

SODIUM AND POTASSIUM

Refining raises the sodium intake by 12 percent (due to the cornflakes) while reducing the potassium intake by 31 percent. As a result the diet sodium: potassium ratio rises by 63 percent (Table 1). However, refining appears to increase the proportion of potassium absorbed while having much less effect on sodium (21,71,81). Thus the net increase in the ratio of absorbed sodium: absorbed potassium is of the order of 25 percent.

Much evidence has accrued associating an excess sodium intake with hypertension (82-85). Potassium, on the other hand, tends to counteract the hypertensiogenic effect of sodium (84-87). Refining may therefore be a contributory cause, albeit minor, of hypertension.

CONCLUSIONS

Nutrition suffers from the legacy of the classic one nutrient-one deficiency disease discoveries. The attitude is still prevalent that unless a clear deficiency disease exists, then an increased consumption of a nutrient is of no possible benefit. This somewhat sterile approach has greatly hindered the concept of sub-clinical deficiency from being accepted. Yet, as demonstrated here, in numerous cases, the likelihood of a particular disease manifesting itself may be appreciably reduced by boosting the intake of a nutrient even when there may be no classical evidence of a deficiency.

In the case of the association between carbohydrate refining and dietary fiber deficiency disease, the evidence is so strong that the hypothesis has gained considerable support fairly quickly. Indeed, for many people, wholewheat bread has became synonymous with fiber. Yet the consequences of refining go far beyond loss of fiber.

With many of the previously discussed nutrient - disease associations refining is only a partial cause of sub-clinical deficiency, which is, in turn, only a partial cause of the disease. Nevertheless, many of the diseases discussed here are so widespread and so serious (diabetes, cancer, CHD) that several partial causations add up to a major health problem.

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