

## **Nutrient composition of ready-to-eat breakfast cereals** (Komposisi nutrien bijirin sarapan sedia dimakan)

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Key words: breakfast cereals, chocolate flavoured, fruit flavoured, nutrient composition

### **Abstrak**

Komposisi nutrien dalam 16 bijirin sarapan sedia dimakan telah ditentukan. Tujuh produk tersebut berperisa coklat, lima berperisa buah-buahan dan selebihnya berperisa asli. Bahan mentah dan komposisi nutrien yang ditunjukkan di label pembungkusan produk disenaraikan. Kebanyakan komposisi nutrien yang terdapat di label tidak jauh berbeza dengan keputusan analisis yang diperoleh dari makmal. Produk tersebut mengandungi nutrien perlu dalam kuantiti yang ketara. Dua produk (B3 dan BC5) mempunyai kandungan lemak tertinggi iaitu  $20.8 \pm 0.1$  dan  $21.1 \pm 0.2$  g/100 g serta kandungan tenaga tertinggi iaitu  $475 \pm 0$  dan  $481 \pm 0$  kkal/100 g. Perhatian perlu diberikan pada kandungan natrium yang tinggi iaitu antara  $509 \pm 3$  hingga  $812 \pm 4$  mg/100 g di dalam enam produk (BC3, BC4, BC6, B1, B2 dan B3). Satu daripada produk berperisa coklat, BC4 mengandungi asid askorbik tertinggi ( $102.3 \pm 2.0$  mg/100 g).

### **Abstract**

Nutrient composition of 16 ready-to-eat breakfast cereals were determined. Seven products were chocolate flavoured, five were fruit flavoured while the others were not flavoured. The ingredients and nutrient composition declared on the product labels were tabulated. Most of the nutrient composition on the product labels were in close proximity to the laboratory results. The products contained appreciable amounts of essential nutrients. Two products (B3 and BC5) had the highest fat contents of  $20.8 \pm 0.1$  and  $21.1 \pm 0.2$  g/100 g, respectively as well as energy contents of  $475 \pm 0$  and  $481 \pm 0$  kcal/100 g, respectively. The high amount of sodium ranging from  $509 \pm 3$  to  $812 \pm 4$  mg/100 g in six products (BC3, BC4, BC6, B1, B2 and B3) needs attention. One of the chocolate flavoured products, BC4 contained the highest amount of ascorbic acid ( $102.3 \pm 2.0$  mg/100 g).

### **Introduction**

The increasing popularity of ready-to-eat (RTE) breakfast cereals is obviously seen by the growing number of different brands and types available in the market to meet the variety of tastes and nutritional requirements of consumers. The gradual change of

breakfast pattern to that which has been practised by the west is simply due to consumers' health awareness, busy schedule and knowledge on the nutritional values of RTE breakfast cereals.

There is no age barrier to the consumption of RTE breakfast cereals. They

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are widely consumed by all ages. They are providers of fibre, complex carbohydrate and micronutrients without added fat (Syrette et al. 1990). A dietary survey of 488 infants aged 6 to 12 months in U.K. showed that almost all of them consumed some family foods including breakfast cereals (Mills 1993). In another study of 136 school children of 7–8 years old in Scotland, it was found that RTE breakfast cereal was most popular among 80% girls and 74% boys (Ruxton et al. 1993). The popularity of RTE breakfast cereals is further demonstrated by most of the 2 082 Tasmanian high school students (12–15 years old) in Australia who reported that they had breakfast cereals 5 days/week (Williams et al. 1993).

RTE breakfast cereals can be categorised according to their manufacturing processes such as flaked, gun-puffed whole grains, extruded gun-puffed, shredded whole grains, extruded shredded, oven-puffed and granolas (Fast 1987). They can also be grouped according to their main base materials such as:

- wheat (shredded wheat biscuit, flakes, malted flakes, bean flakes, flakes and raisins, bran, puffed wheat, coated puffed wheat and malted granules),
- corn (flakes, coated flakes, coated puffed corn and puffed shredded corn biscuits),
- rice (puffed, coated puffed rice, coated rice, rice flakes and puffed shredded rice biscuits),
- oat (puffed, coated puffed and flakes), and
- other cereals or multi-cereals.

Many RTE breakfast cereals are fortified with fibre, minerals (iron, zinc and calcium) and vitamins (B complex, A and C) to enhance the nutritional profile of consumers. Water soluble fibre has been reported to reduce serum cholesterol and high soluble fibre in oat bran might contribute to the lowering of low density lipoprotein in a lipid-lowering diet (Poulter et al. 1994). Folic acid was reported to prevent spina bifida or neural tube birth

defect. In fact, the US Food and Drug Authority had proposed for mandatory folic acid enrichment of cereal-based foods. Therefore, breakfast cereals would be enriched to 0.1 mg folate per serving considering the recommended daily consumption of 0.4 mg of folate by women of child-bearing age (Gorton 1993).

Numerous studies had demonstrated a positive correlation between individual's overall nutritional status and the regular consumption of breakfast cereals. A study in the U.S.A. found that RTE cereal consumption at breakfast had a pronounced positive influence on daily vitamin B and C intakes, in addition to promoting significantly higher daily intakes of vitamin A and most minerals in four population groups ranging from children 5–12 years to women 62 years and older (Zabik 1987). A U.K. study also revealed that children who consumed breakfast cereals regularly had higher intakes of vitamin B<sub>2</sub>, nicotinic acid, vitamin B<sub>6</sub> and folate than those who did not (Ruxton et al. 1993). In another study, Webster (1995) revealed that RTE breakfast cereals were low in fat and provided a significant proportion of nutrients essential for growth in children.

The emerging importance of RTE breakfast cereals in the country had led to this study on the nutrient composition of 16 of them. The products were mainly chocolate flavoured and fruit flavoured as the information were used in the development of similar products from local raw materials. This report includes a comparison between the nutrient composition claimed by the manufacturers and that analysed by our laboratory.

## **Materials and methods**

### ***Types of RTE breakfast cereals***

Sixteen types of commercially available RTE breakfast cereals were studied (*Table 1*). For the purpose of this study, they were grouped into three i.e. chocolate flavoured, fruit flavoured and others. Thirteen of them (BC3, BC4, BC5, BC6,

BC7, BF2, BF3, BF4, BF5, B1, B2, B3 and B4) were imported while the rest (BC1, BC2 and BF1) were locally processed. Their cost price per 100 g varied from RM1.39 to RM3.73. They were packaged in various sizes ranging from 25 g/box to 600 g/box. Eleven of them contained wheat (whole wheat and flour), four of them contained rice (flour and whole rice), three of them contained corn (meal and flour), three of them contained oat (flour, rolled oats, bran and germ), and one of them contained malted barley flour. Nine of them claimed to be fortified with vitamins and minerals while three of them claimed to be fortified only with vitamins. The rest did not mention about fortification.

### **Sampling**

A sample of 500 g of each type of RTE breakfast cereals was blended and analysed for various nutrients. Each sample (from one batch) was obtained from the Klang Valley. Each analysis was carried out in duplicates.

### **Proximate composition**

Analyses for proximate composition were carried out according to the methods of the AOAC (1984) and Tee et al. (1986). Energy was determined by using an adiabatic bomb calorimeter (IKA C4000, Germany). Carbohydrate was calculated by difference. Total, insoluble and soluble dietary fibre were analysed according to Lee et al. (1993).

### **Minerals**

The minerals were determined as described by Khatijah et al. (1997).

### **Vitamins**

The vitamins were determined as described by Khatijah et al. (1997).

## **Results and discussion**

### **Proximate composition**

The energy content of the RTE breakfast cereals analysed ranged from  $348 \pm 0$  to  $481 \pm 0$  kcal/100 g (Table 2). The high fat

content in BC5 ( $21.1 \pm 0.2\%$ ) and B3 ( $20.8 \pm 0.1\%$ ) contributed to their high calorie values of  $481 \pm 0$  kcal/100 g and  $475 \pm 0$  kcal/100 g, respectively. The desirable dietary fat for Malaysians is between 20–30% kcal (Ministry of Health, Malaysia 1999). Thus, for a 2 100 kcal diet the dietary fat intake will be 47 g (20% kcal dietary fat level) and 70 g (30% of kcal dietary fat level).

The addition of cocoa as well as vegetable fat in BC5 and vegetable shortening as well as soyabean/cottonseed oil in B3 might contribute to the high fat content. The available energy values on the product labels were close to those obtained by our laboratory except for BF2, BF5, B3 and B4. The difference could be due to the determination method and batch analysis. Energy values obtained by calculation would involve values for fat, protein and carbohydrate. The numerous steps taken to obtain the values would contribute to higher risk of errors.

Thirteen of the products contained  $5.8 \pm 0\%$  moisture or less while B1, BF3 and BF4 had  $7.2 \pm 0$ ,  $9.9 \pm 0$  and  $10.4 \pm 0\%$ , respectively. Sausageot and Blond (1991) reported that a slight decrease in sensory crispness intensity of breakfast cereals occurred between 0 and 0.5 (water activity,  $a_w$ ) or 7% moisture content, after which there was a very rapid decrease. In another report by Peleg (1994) stated that the crunchiness and crispness loss occurred when the water activity values were 0.28 and 0.55, respectively.

The protein content ranged from  $5.8 \pm 0.2$  to  $10.3 \pm 0.3$  g in 14 of the products while that in B4 was relatively high ( $15.7 \pm 0.2$  g) and that in BC6 was low ( $3.4 \pm 0.2$  g). The recommended daily intake of protein for Malaysians is 53 g (Tee et al. 1997). The carbohydrate content ranged from  $61.6 \pm 0.1$  to  $87.7 \pm 0.2$  g. The product B4 contained high crude fibre ( $4.2 \pm 0$  g) while the others had  $2.1 \pm 0$  g or less.

The available total dietary values on the product labels were in close proximation

Table 1. Description and ingredients used in 16 ready-to-eat (RTE) breakfast cereals

RTE breakfast cereals	Description by manufacturers	Local/Imported	Cost (RM/100 g)	Package (g/box)	Ingredients
<i>Chocolate flavoured</i>					
BC1	–	Local	2.29	170	Rice, wheat, malt extract, cocoa powder, skimmed milk powder, palm oil, palm kernel oil and milk fat
BC2	–	Local	2.40	25	Wheat flour, sugar, brown sugar, cocoa powder, palm kernel oil, malt extract, salt, permitted food conditioner (soy lecithin) and permitted natural flavouring, all of plant origin
BC3	Puffed rice with natural cocoa, 7 vitamins and iron	Imported (Australia)	2.27	275	Whole rice, sugar, cocoa powder, salt, skimmed milk powder, malt extract, imitation chocolate flavour, vitamins (vitamin C, vitamin A, niacin, thiamine, riboflavin, vitamin B <sub>6</sub> , vitamin D), dextrose and iron
BC4	–	Imported	1.77	150	Corn meal, sugar, cocoa powder, salt, soybean oil, sodium bicarbonate, malt powder, sodium ascorbate, flavour (vanillin), cereal solids, niacinamide, reduced iron, riboflavin (vitamin B <sub>2</sub> ), thiamine mononitrate (vitamin B <sub>1</sub> ), pyridoxime hydrochloride (vitamin B <sub>6</sub> ), folic acid and cyanocobalamin (vitamin B <sub>12</sub> )
BC5	–	Imported	3.73	150	Milk chocolate, sugar, full cream milk solids, cocoa fat, cocoa mass, lecithin, flavour, glucose syrup, malt extract, skimmed milk solids, water, vegetable fat, wheat flour, sugar, gluten, pectin and salt

(cont.)

Table 1. (cont.)

RTE breakfast cereals	Description by manufacturers	Local/Imported	Cost (RM/100 g)	Package (g/box)	Ingredients
BC6	-	Imported	3.62	390	Sugar, corn meal, corn flour, corn syrup, modified corn starch, cocoa processed with alkali, wheat starch, partially hydrogenated cottonseed and soybean oil, salt, fructose, dicalcium phosphate, beet powder and caramel colour, baking soda, artificial flavour, trisodium phosphate, freshness preserved by BHT, vitamin C (sodium ascorbate), niacin, iron, vitamin B <sub>6</sub> (pyridoxine hydrochloride), vitamin B <sub>2</sub> (riboflavin), vitamin B <sub>1</sub> (thiamine mononitrate), folic acid and vitamin B <sub>12</sub>
BC7	Crispy oat pillows with hazelnut chocolate filling	Imported (United Kingdom)	1.99	375	Oat flour, sugar, wheat flour, vegetable fat, skimmed milk powder, hazelnuts, cocoa powder, salt, emulsifier (lecithin), natural flavourings, iron, vitamins: niacin, B <sub>5</sub> , B <sub>2</sub> , B <sub>6</sub> , B <sub>1</sub> , folic acid, biotin, and B <sub>12</sub>
<i>Fruit flavoured</i>					
BF1	Fortified with 7 vitamins and iron	Local	2.24	170	Corn, sugar, wheat, apple puree, vegetable oil (plain/coconut/corn), skimmed milk powder, salt, malt extract, vitamins, minerals, permitted food conditioner, natural colouring and apple flavouring
BF2	Provides 13 vitamins and minerals	Imported (USA)	1.71	439	Whole wheat, rolled oats, brown sugar, walnuts, sugar, rice, partially hydrogenated sunflower oil, dried bananas, corn syrup, salt, wheat flour, malted barley flour, natural flavouring, whey and BHT (added to preserve freshness)
BF3	100% natural shredded whole wheat, apricot flavour, low salt, low fat, good source of fibre, no added flavourings and colourings	Imported (Australia)	1.39	475	Whole wheat, fruit paste, dried sultanas, dried apricots, honey, apple juice concentrate, dried apples, sugar, vitamins (niacin, riboflavin and thiamine)

(cont.)

Table 1. (cont.)

RTE breakfast cereals	Description by manufacturers	Local/Imported	Cost (RM/100 g)	Package (g/box)	Ingredients
BF4	100% natural shredded whole wheat, black currant variety, low salt, low fat, good source of fibre, no added flavourings and colourings	Imported (Australia)	1.39	475	Whole wheat, fruit paste, dried dates, dried sultanas, pear juice concentrate, glycerol, black currant juice concentrate, sugar, vitamins (niacin, riboflavin) and thiamine
BF5	Light rice based cereal with a spicy fruit flavour	Imported (United Kingdom)	2.93	375	Rice flour, sugar, concentrated apple juice, dried apple, salt, dried skimmed milk, cinnamon, calcium carbonate, niacin, iron, riboflavin, thiamine, folic acid, vitamin D and vitamin B <sub>12</sub>
<i>Others</i>					
B1	4 essential nutrients	Imported (Australia)	2.50	110	Milled rice, sugar, salt, malt extract, vitamins and minerals
B2	Malted wheat with 3 added vitamins	Imported (United Kingdom)	1.51	600	Whole wheat, sugar, malt extract, salt, dextrose, niacin, riboflavin and thiamine
B3	Wheat snack crackers with snappy taste	Imported (USA)	2.93	198	Enriched flour, wheat flour, niacin, reduced iron, thiamine, mononitrate (vitamin B <sub>1</sub> ), riboflavin (vitamin B <sub>2</sub> ), vegetable shortening (partially hydrogenated), soybean and/or cottonseed oils, dehydrated potatoes, steamed crushed wheat, salt, sugar, defatted wheat germ, corn syrup, malt, onion powder, monosodium glutamate, soy lecithin, sodium bicarbonate, spice and natural flavour
B4	High fibre cereal, toasted oat bran, higher fibre and protein than a normal oat product	Imported (United Kingdom)	1.50	250	Oat bran and oat germ. No added salt, sugar, additives or preservative

Table 2. Proximate composition of ready-to-eat (RTE) breakfast cereals (per 100 g)

RTE breakfast cereals	Energy (kcal)	Moisture (%)	Protein (g)	Fat (g)	Carbo-hydrate (g)	Crude fibre (g)	Total dietary fibre (g)	Insoluble dietary fibre (g)	Soluble dietary fibre (g)	Ash (g)
BC1	391 ± 0	1.8 ± 0	8.2 ± 0.1	1.8 ± 0.2	85.6 ± 0.2	0.7 ± 0.2	n.a.	n.a.	n.a.	1.9 ± 0.3
BC2	398 ± 0	2.9 ± 0	9.5 ± 0.1	3.6 ± 0.1	82.0 ± 0.1	0.5 ± 0.2	7.2 ± 0.1	4.9 ± 0.2	2.3 ± 0.2	1.5 ± 0
BC3	377 ± 0 (383)	3.4 ± 0.1 (-)	5.8 ± 0.2 (5.3)	0.5 ± 0 (0.3)	87.3 ± 0.2 (88.3)	0.9 ± 0.1 (-)	2.7 ± 0.2 (1.3)	2.1 ± 0.2 (-)	0.6 ± 0.2 (-)	2.1 ± 0.1 (-)
BC4	382 ± 0	3.3 ± 0.1	5.9 ± 0.2	1.1 ± 0.1	87.3 ± 0.2	0.2 ± 0.1	n.a.	n.a.	n.a.	2.2 ± 0.2
BC5	481 ± 0	2.9 ± 0.1	8.2 ± 0.1	2.1 ± 0.2	64.5 ± 0.1	1.4 ± 0.2	n.a.	n.a.	n.a.	1.9 ± 0
BC6	411 ± 0	3.3 ± 0	3.4 ± 0.2	6.7 ± 0	84.2 ± 0.2	0.1 ± 0	n.a.	n.a.	n.a.	2.3 ± 0
BC7	423 ± 0 (443)	3.9 ± 0 (-)	10.3 ± 0.3 (10.9)	10.9 ± 0.1 (15.2)	70.8 ± 0.2 (65.6)	1.0 ± 0.2 (-)	n.a. (3.6)	n.a. (-)	n.a. (-)	3.1 ± 0.1 (-)
BF1	389 ± 0 (387)	2.6 ± 0.1 (-)	7.0 ± 0 (5.5)	1.0 ± 0.1 (2.9)	87.7 ± 0.2 (84.8)	0.2 ± 0.2 (-)	n.a. (2.1)	n.a. (-)	n.a. (-)	1.5 ± 0 (1.7)
BF2	450 ± 0 (424)	5.0 ± 0 (-)	8.8 ± 0.1 (9.0)	16.6 ± 0 (10.0)	66.4 ± 0.1 (73.0)	1.1 ± 0 (-)	11.1 ± 0.2 (6.8)	9.4 ± 0.2 (-)	1.4 ± 0.2 (-)	2.1 ± 0 (-)
BF3	350 ± 0 (358)	9.9 ± 0 (-)	7.9 ± 0.2 (8.0)	0.9 ± 0.1 (1.1)	77.5 ± 0.2 (82.9)	2.0 ± 0.2 (-)	n.a. (11.9)	n.a. (-)	n.a. (-)	1.8 ± 0.2 (-)
BF4	348 ± 0 (360)	10.4 ± 0 (-)	7.7 ± 0.1 (7.6)	0.8 ± 0.1 (1.5)	77.6 ± 0.1 (82.9)	2.0 ± 0 (-)	12.6 ± 0.2 (11.8)	11.8 ± 0.3 (-)	0.8 ± 0.1 (-)	1.5 ± 0 (-)
BF5	427 ± 0 (390)	2.9 ± 0 (-)	7.2 ± 0.2 (4.7)	1.7 ± 0.1 (1.9)	86.2 ± 0.2 (92.6)	0.4 ± 0.1 (-)	n.a. (3.4)	n.a. (-)	n.a. (-)	1.6 ± 0.1 (-)
B1	371 ± 0 (367)	7.2 ± 0 (-)	6.9 ± 0.1 (5.6)	2.2 ± 0.2 (1.3)	80.7 ± 0.2 (87.1)	0.2 ± 0 (-)	25.1 ± 0.1 (3.3)	17.6 ± 0.1 (-)	6.1 ± 0.1 (-)	2.8 ± 0.2 (-)
B2	370 ± 0 (352)	3.9 ± 0.1 (-)	10.3 ± 0 (11.6)	0.9 ± 0.1 (2.1)	80.1 ± 0.1 (75.0)	2.1 ± 0 (-)	n.a. (8.7)	n.a. (-)	n.a. (-)	2.7 ± 0.1 (-)
B3	475 ± 0 (500)	3.0 ± 0.1 (-)	10.3 ± 0 (10.0)	20.8 ± 0.1 (23.3)	61.6 ± 0.1 (60.0)	1.2 ± 0.2 (-)	n.a. (3.3)	n.a. (-)	n.a. (-)	3.1 ± 0.1 (-)
B4	359 ± 0 (383)	5.8 ± 0 (-)	15.7 ± 0.2 (16.3)	5.0 ± 0.2 (9.3)	67.7 ± 0.2 (62.6)	4.2 ± 0 (-)	n.a. (18.5)	n.a. (-)	n.a. (-)	1.6 ± 0 (-)

Values (without brackets) are mean ± SD and are on fresh weight basis

Values within brackets were declared on the product labels

- = Values which were not declared on the product labels

n.a. = Not analysed

to those obtained from our laboratory. BF2 and BF4 were found to contain high amounts of dietary fibre i.e.  $11.1 \pm 0.2$  g/100 g and  $12.6 \pm 0.2$  g/100 g, respectively. From the product labels, BF3 and B4 also seemed to contain high amounts of dietary fibre. These could be due to the presence of whole wheat, rolled oats and dried bananas in BF2; whole wheat, fruit paste, dried sultanas, dried apricots, apple juice concentrate and dried apples in BF3, whole wheat, fruit paste, dried dates, dried sultanas, pear juice concentrate and black

currant juice concentrate in BF4; and oat bran and oat germ in B4. The insoluble dietary fibre constituted the major portion of the fibre in the analysed five products (BC2, BC3, BF2, BF4 and B1). The recommended dietary intake of fibre ranges from 20–30 g per day (Ministry of Health, Malaysia 1999).

### Minerals

Thirteen of the products contain  $\leq 120 \pm 3$  mg/100 g calcium while two (BF1 and BC5) of them had  $>200$  mg/100 g (Table 3). This might be due to the mineral

Table 3. Mineral composition of ready-to-eat (RTE) breakfast cereals (mg per 100 g)

RTE breakfast cereals	Calcium	Phosphorus	Iron	Sodium	Potassium	Magnesium	Copper	Zinc
BC1	$89 \pm 5$	$181 \pm 3$	$14.6 \pm 0.6$	$301 \pm 3$	$316 \pm 5$	$61 \pm 0$	$0.2 \pm 0$	$2.0 \pm 0.2$
BC2	$22 \pm 2$	$16 \pm 1$	$0.3 \pm 0.1$	$198 \pm 2$	$354 \pm 3$	$47 \pm 0$	$0.1 \pm 0$	$0.5 \pm 0.1$
BC3	$51 \pm 3$ (–)	$98 \pm 3$ (–)	$11.3 \pm 2.0$ (8.3)	$643 \pm 6$ (740)	$230 \pm 3$ (237)	$33 \pm 2$ (–)	$0.5 \pm 0.1$ (–)	$1.7 \pm 0.1$ (–)
BC4	$10 \pm 1$	$107 \pm 1$	$0.2 \pm 0$	$509 \pm 3$	$348 \pm 3$	$38 \pm 1$	0	$0.6 \pm 0$
BC5	$217 \pm 3$	$96 \pm 3$	$0.2 \pm 0$	$121 \pm 2$	$374 \pm 4$	$43 \pm 2$	$0.2 \pm 0$	$1.1 \pm 0.1$
BC6	$79 \pm 4$	$130 \pm 2$	$0.7 \pm 0.1$	$536 \pm 5$	$151 \pm 2$	$43 \pm 3$	$0.2 \pm 0$	$1.1 \pm 0.1$
BC7	$120 \pm 3$ (–)	$238 \pm 3$ (–)	$14.6 \pm 0.4$ (–)	$268 \pm 2$ (300)	$382 \pm 3$ (–)	$67 \pm 3$ (–)	$0.3 \pm 0$ (–)	$1.6 \pm 0.1$ (–)
BF1	$205 \pm 8$ (–)	$56 \pm 2$ (–)	$1.9 \pm 0.1$ (14)	$134 \pm 4$ (–)	$136 \pm 5$ (–)	$15 \pm 0.2$ (–)	$0.1 \pm 0$ (–)	$0.4 \pm 0$ (–)
BF2	$54 \pm 0$ (–)	$235 \pm 5$ (–)	$3.4 \pm 0.1$ (–)	$326 \pm 3$ (339)	$340 \pm 0$ (322)	$84 \pm 1$ (–)	$0.4 \pm 0$ (–)	$0.6 \pm 0$ (–)
BF3	$30 \pm 1$ (–)	$192 \pm 3$ (–)	$2.8 \pm 0.2$ (–)	$7 \pm 0$ (26)	$441 \pm 5$ (379)	$71 \pm 1$ (–)	$0.3 \pm 0$ (–)	$1.4 \pm 0$ (–)
BF4	$30 \pm 1$ (–)	$205 \pm 3$ (–)	$5.2 \pm 0.1$ (–)	$8 \pm 1$ (27)	$436 \pm 4$ (350)	$75 \pm 2$ (–)	$0.3 \pm 0$ (–)	$1.4 \pm 0.1$ (–)
BF5	n.a. (–)	n.a. (–)	n.a. (–)	n.a. (400)	n.a. (–)	n.a. (–)	n.a. (–)	n.a. (–)
B1	$5 \pm 0$ (–)	$96 \pm 4$ (–)	$3.6 \pm 0.2$ (16.6)	$707 \pm 5$ (–)	$107 \pm 2$ (–)	$25 \pm 2$ (–)	$0.1 \pm 0$ (–)	$0.8 \pm 0$ (–)
B2	$36 \pm 1$ (–)	$259 \pm 0$ (–)	$3.8 \pm 0.3$ (–)	$571 \pm 4$ (500)	$395 \pm 3$ (–)	$76 \pm 0$ (–)	$0.4 \pm 0$ (–)	$1.8 \pm 0$ (–)
B3	$27 \pm 2$ (–)	$146 \pm 4$ (–)	$3.8 \pm 0.2$ (–)	$812 \pm 4$ (1067)	$357 \pm 3$ (–)	$50 \pm 3$ (–)	$0.2 \pm 0$ (–)	$1.2 \pm 0$ (–)
B4	$85 \pm 3$ (–)	$113 \pm 5$ (–)	$5.3 \pm 0.2$ (4.5)	$5 \pm 0$ (–)	$547 \pm 5$ (–)	$173 \pm 2$ (–)	$0.4 \pm 0$ (0.5)	$3.3 \pm 0$ (3.8)

Values (without brackets) are mean  $\pm$  SD and are on fresh weight basis

Values within brackets were declared on the product labels

– = Values which were not declared on the product labels

n.a. = Not analysed



fortification in BF1 and full cream milk solids in BC5 as specified by the labels. The recommended dietary intake of calcium is 450 mg/day g (Tee et al. 1997).

Phosphorus content of one product, BC2 was  $16 \pm 1$  mg/100 g while that in the rest ranged between  $56 \pm 2$  mg/100 g to  $259 \pm 0$  mg/100 g. Four of the products (BC2, BC4, BC5 and BC6) had  $<1$  mg/100 g iron while three (BC1, BC3 and BC7) had  $>10$  mg/100 g iron. The high values could be due to the iron fortification as declared on the labels of BC3 and BC7. The iron content in BF1 and B1 were claimed (on the labels) to be much higher than our laboratory's results. This could be due to the different analytical technique used.

The sodium content was moderate to high in 12 products (from  $121 \pm 2$  mg/100 g to  $812 \pm 4$  mg/100 g) and very low in three products (from  $5 \pm 0$  mg/100 g to  $8 \pm 1$  mg/100 g). The recommended daily intake of sodium is 500 mg/day (Ministry of Health, Malaysia 1999).

Potassium was present in the range of  $107 \pm 2$  mg/100 g to  $547 \pm 5$  mg/100 g. The product B4 which consisted of oat bran and oat germ had very high magnesium content of  $173 \pm 2$  mg/100 g while the rest had  $15 \pm 0.2$  mg/100 g to  $84 \pm 1$  mg/100 g. Higher concentration of trace minerals are found in the outer layers of the cereal grains (bran), compared to the inner kernel.

Copper was present in very low amount (from  $0.1 \pm 0$  mg/100 g to  $0.5 \pm 0.1$  mg/100 g) and absent in one product, BC4. Besides B4 which contained  $3.3 \pm 0$  mg/100 g zinc the others had between  $0.4 \pm 0$  mg/100 g to  $2.0 \pm 0.2$  mg/100 g zinc. This is in agreement with the study carried out by Chang et al. (1992) which stated that bran-based breakfast cereals contained comparatively higher levels of zinc and manganese.

### **Vitamins**

The labels on ten of the products declared the addition of vitamins which may compensate for the loss during processing

and handling. Thus, the vitamin contents of the products varied. The vitamin A was in the range of  $2 \pm 0$  to  $103 \pm 2$   $\mu$ g RE/100 g (Table 4). Both retinol and  $\beta$ -carotene contributed to the total vitamin A activity. The high vitamin A content in BC3 ( $250$   $\mu$ g/100 g) as declared on the product label did not state if it was expressed in terms of RE.

The products had low thiamine ( $0.05 \pm 0$  to  $0.37 \pm 0.20$  mg/100 g) and reasonable riboflavin ( $0.04 \pm 0.01$  to  $2.21 \pm 0.11$  mg/100 g) contents. The product, BC4 contained high amount of ascorbic acid ( $102.3 \pm 2.0$  mg/100 g), seven others had  $>10$  mg/100 g while the rest had  $<10$  mg/100 g. The recommended daily intake of ascorbic acid is 30 mg/day g (Tee et al. 1997).

### **Conclusion**

The RTE breakfast cereals analysed contained appreciable amounts of essential nutrients. The high amount of sodium in a few of them needs attention as high level may lead to hypertension and cardiovascular diseases. Besides acquiring the desired high levels of essential nutrients in the products by fortification, consideration has to be taken that addition of inorganic metal or undesirable chemical form may not be of nutritional benefit. This is due to the bioavailability of the nutrients to the body.

The high consumers acceptance and increasing consumption of RTE breakfast cereals can contribute to the daily intake of essential nutrients. The actual levels of intake will depend on the type of cereals, the processing method to which it has been subjected and the amount consumed. Realising this potential the manufacturers may have to play a more responsible role to improve further the nutrient composition of RTE breakfast cereals.

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Table 4. Mineral composition of ready-to-eat (RTE) breakfast cereals (mg per 100 g)

RTE breakfast cereals	Retinol (µg)	β-carotene (µg)	Vit. A (µg RE*)	Thiamine (mg)	Riboflavin (mg)	Ascorbic acid (mg)
BC1	49 ± 1	2 ± 0	49 ± 2	0.37 ± 0.20	1.37 ± 0.20	32.8 ± 0.3
BC2	87 ± 2	96 ± 1	103 ± 2	0.26 ± 0	0.11 ± 0	75.9 ± 2.1
BC3	6 ± 0 (-)	2 ± 0 (-)	6 ± 0 (250)	0.16 ± 0.10 (0.93)	1.21 ± 0.30 (1.33)	20.1 ± 0.8 (25.0)
BC4	24 ± 2	26 ± 2	28 ± 2	0.25 ± 0.05	2.00 ± 0.06	102.3 ± 2.0
BC5	39 ± 1	106 ± 2	57 ± 2	0.10 ± 0.02	0.04 ± 0.01	10.6 ± 1.0
BC6	39 ± 2	137 ± 2	62 ± 2	0.20 ± 0	0.42 ± 0.04	21.0 ± 2.0
BC7	12 ± 1	1 ± 0	12 ± 0	0.33 ± 0.02	2.21 ± 0.11	4.5 ± 0
BF1	19 ± 1 (-)	110 ± 4 (-)	37 ± 2 (-)	0.25 ± 0.03 (1.40)	1.20 ± 0.08 (1.80)	33.7 ± 0.2 (60.00)
BF2	1 ± 0	8 ± 1	2 ± 0	0.30 ± 0	1.30 ± 0.20	7.6 ± 0.4
BF3	24 ± 1	176 ± 3	53 ± 1	0.10 ± 0	1.54 ± 0.07	2.3 ± 0
BF4	20 ± 2	3 ± 0	21 ± 1	0.07 ± 0	1.03 ± 0.01	2.2 ± 0
BF5	6 ± 0	2 ± 0	6 ± 0	0.19 ± 0	2.08 ± 0.02	4.8 ± 0.1
B1	12 ± 2 (-)	2 ± 1 (-)	12 ± 1 (-)	0.22 ± 0.01 (1.86)	1.24 ± 0.02 (0.20)	7.1 ± 0 (-)
B2	14 ± 0	3 ± 0	15 ± 0	0.16 ± 0.2	1.12 ± 0	6.8 ± 0.5
B3	6 ± 1	2 ± 0	6 ± 1	0.05 ± 0	0.28 ± 0.02	13.0 ± 1.0
B4	10 ± 1 (-)	6 ± 1 (-)	11 ± 1 (-)	0.06 ± 0.01 (0.77)	0.14 ± 0.01 (0.20)	3.8 ± 0 (-)

RE\* = Retinol equivalent

Values (without brackets) are mean ± SD and are on fresh weight basis

Values within brackets were declared on the product labels

- = Values which were not declared on the product labels

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