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A HUMAN NEED FOR B12

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B12 need and sources

Vitamin B12 is the most common area of concern surrounding insufficiency for those following a plant-based or vegan diet (1). The human body is not equipped to make B12 itself and therefore B12 can only be delivered into the human body from dietary ingestion of animal-based products, supplementation or from fortified foods (2). Vitamin B12 is a water-soluble vitamin that can be stored in the liver. Excess B12 is excreted by the body via sweat, urine and faeces, which increases the need for regular dietary intake to ensure sufficient needs are met (3).

How much do humans need?

In the UK recommended minimal values of B12 are 1.2-1.5mcg/d (4), yet the European food standards recommend 4mcg/d (5) and ‘mega-doses’ observed by elite athletes in quantities greater than 50-100 times the UK recommendation (6). Due to B12 regarded as a safe nutrient no upper limit value is given. However due to malnutrition through lack of food or personal diet changes, B12 deficiency is emerging as the most common nutrient deficiency globally (7). This is presenting a severe problem in the Indian subcontinent, Mexico, central and south America and parts of Africa; caused by low intake or lack pf access to animal derived foods, lack of access to fortified foods, malabsorption and/or aging. Symptoms of B12 deficiency include demyelination of neurones, neurological malfunction, neuropathy, impaired nerve pathways, depression, pale skin, heart palpitations light-headedness, dizziness, cognitive decline and poor skin healing (8).

At risk populations of deficiency are aging adults, patients post gastric surgery, vegans, long term restrictive diets, digestive disorders such as Crohn’s and pernicious anaemia (9). All of which require higher intakes of highly bio-available B12 due to inhibited absorption. Also, individuals on long term medications such as metformin and proton inhibitors have been identified as restrictors of B12 absorption from dietary and supplemental sources. This is an area of prospective growth with a rise in the prevalence of T2DM within the western and global population (10). Vegan pregnant females must ensure the intake of B12 is optimal for their own needs as well as the foetal development, low B12 has presented higher incidences of low birth weight, pre-eclampsia and the development of diabetes in the chid, nursing mothers need to maintain B12 intake to support self and child development (11).

Along with supplementation, fortification of cereals, plant-based milks and yeast extracts are regarded as good sources for delivery of B12. However, the highest bioavailability of B12 is derived from meat, dairy and eggs, supporting the keto, carnivore, omnivore, flexitarian and mixed model diets. The use of the fortified foods provides B12 in non-animal derived products (12). In table 1 a list of the B12 content per 100g/ml and per serving can be seen.

Table 1; Quality of B12 in common foods (13).

Food source Average per category	ug per 100g/ml	Suggested serving size (8)	ug per serving size
Cooked liver	84	80g	67.2
Fortified nutritional yeast	22	25g	5.5
Fish	2.5-5	140g	3.5-7
Fortified Tofu	1.5	100g	1.5
Fish	2.5-5	140g	3.5-7
Fortified breakfast cereal	4	30g	1.2
Red meat	1.4	90g	1.26
Whole milk	2.2	200ml	4.4
Cheese	0.9	30g	0.27
Yogurt (non-flavoured)	0.6	125g	0.75
Chicken egg	0.6 (1 x medium egg)	2x eggs	1.2
Chicken breast	0.3	90g	0.27

Table 2 provides the mean B12 intake of male individuals following diets that include animal products, differing combined approaches and animal free.

Table 2; A 2002 study by Davey collated the mean intake of B12 per day ingested per dietary group (14).

Dietary model	B12 ug per day
Vegan	0.9
Lacto-ovo	250
Pescatarian	500
Meat eater	6951

What about herbivores?

All animals require vitamin B12. Herbivores that are ruminates, are equipped with the mechanisms to produce their own B12, via specific bacteria hosted within the rumen and reticulum chambers of their stomachs (15). Other herbivores such as rabbits are required to pass food through the gastrointestinal tract twice; producing dropping pellets to be eaten again to maximise the absorption of all micronutrients, including B12.

Humans are mono-gastric, as are the great apes and chimpanzees whom are all required to consume meat or insects to obtain B12. The B12 that is bound to the consumed protein is released by hydrochloric acid and gastric protease within the stomach (16). Within humans the bacteria required to produce B12 is present, but only in the colon, where the location of such prevents any potential B12 production or absorption (nutrients can only enter through the small intestine) and therefore cannot get B12 from such pathway.

Supplementary or fortified B12 foods are the only routes for a plant-based diet to obtain B12, in the qualities required to sustain health and generally have a bio-availability of 10ug absorbed for every 500ug supplemented (17). Supplementary B12 is in the form of cyanocobalamin, that the body converts to active forms; methlcobalamin and 5-deoxyadenosylcobalamin or in the form of synthetic methylcobalamin (18,19). The body's ability to absorb B12 is dependent on the capacity of gastric enzymes and intrinsic factor within the stomach, that has an important role so that B12 can be absorbed in the intestine. For individuals who don't produce or utilise intrinsic factor a condition called pernicious anaemia will be present (20).

B12 from plants?

Extensive research is investigating the possibility of procuring B12 from plant sources, however development has not been seen a viable alternative to date and development continues. Possible dietary enhancers being explored for future food development have include the use of microgreens, soybean fermentation, seaweed and algae.

A study using cress saw the uptake of cobalamin accumulate in the vacuole (21) and dried purple laver (nori seaweed) has been the most suitable B12 source to be developed as it is also high in iron and omega-3 fatty acids that are often lacking in the vegan/plant-based diet leading to speculation that B12 can be potentially harvested within plants (22).

The use of B12 fertiliser on soils derived from human and animal faeces (that are high in B12) does show a slight increase in B12 ingestion, however it is believed to be a consequence of the vegetables not being washed and the ingestion of the B12 via faecal matter on the vegetable being the contributor and not from the vegetable increasing nutrient uptake from the fertilised soil.

Biotech laboratory studies have seen successful developments in the isolation of the B12 from the glucose utilising marine species *Streptomyces,* with the possibility of being applied to the pharmaceutical and food industries (23).

The continued development to seek a bio-available, plant-based B12 has created a platform for competitive nutritional and agricultural innovation has emerged to source the increasingly demanded micronutrient.

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