**Kazakh Academy of Nutrition**

# USAID/GAIN MICRONUTRIENT FORTIFICATION PROJECT IN CENTRAL ASIA, AFGHANISTAN AND PAKISTAN

## ANALYSIS AND JUSTIFICATION THE POSSIBILITY OF HARMONIZING STANDARDS FOR REFINED WHEAT FLOUR FORTIFICATION IN CENTRAL ASIA, AFGHANISTAN AND PAKISTAN

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**1. Comparison of standards for refined wheat flour fortification, operating in the Member Countries with the relevant recommendations of the World Health Organization (WHO).**

According to an interim consensus statement, endorsed by WHO and other institutions about recommendations on wheat and maize flour fortification [1] (reference), the average levels of nutrients that can be added to fortifying wheat flour depending on the:

- estimated average per capita consumption (g/day) of wheat flour – for all the recommended micronutrients;
- extraction level of flour (low or high) – for iron and zinc;
- fortifying nutrient – for all the recommended micronutrients, and others are required by the nutrition situation of the country (Table 1).

NaFeEDTA, ferrous sulfate, ferrous fumarate and electrolytic iron may serve as the source of iron. However electrolytic iron cannot be used neither as an iron source in cases where the estimated average per capita consumption of wheat flour is less than 150 g/day nor for high-extraction flour (i.e. whole flour). (high-extraction-rate = ≥80% wheat flour [2]; so, low-extraction-rate = <80% wheat flour). This is because very high levels of electrolytic iron that are needed could negatively affect sensory properties of fortified flour.

The average per capita consumption of wheat flour in the member countries is [3]:

- 258,7 g/day in Kazakhstan;
- 311,3 g/day in Pakistan;
- 350,3 g/day in Tajikistan;
- 377,9 g/day in Kyrgyzstan;
- 439,0 g/day in Afghanistan;
- 467,3 g/day in Uzbekistan.

Due to differences in the average per day consumption of wheat flour per person:

- Kazakhstan assigned to countries where average consumption of wheat flour per capita is 150-300 g/day;
- Pakistan, Tajikistan, Kyrgyzstan, Afghanistan and Uzbekistan – to countries where average consumption of wheat flour per capita is >300 g/day.

Overall, the average levels of per capita per day consumption of flour in the participating countries are high and may contribute to the harmonization of standards for flour fortification.

In 4 countries (Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan) flour is currently requested to be fortified with 6 micronutrients: vitamins $B_1$, $B_2$, $B_3$ (niacin) and $B_9$ (folate), iron and zinc; in Afghanistan , flour is expected to be fortified by 4 micronutrients (vitamins $B_9$ and $B_{12}$, iron and zinc); in Pakistan, – currently only by 2 micronutrients - vitamin $B_9$ and iron, are required at the national level (Table 2). Here, it is important to point out that in Afghanistan and Pakistan, the consumption of high-extraction flour is common, while in the other countries low extraction flour is more popular. For high-extraction flour, the incorporation of vitamins $B_1$, $B_2$, $B_3$ (niacin) is unnecessary as the intrinsic content of these micronutrients in that type of flour is high

The levels of added micronutrients to the flour:

- in Kazakhstan and Tajikistan slightly higher for supreme grade flour than for the first grade one;
- in Kyrgyzstan such differences do not exist;
- in Uzbekistan the data are given for fortification of only the first grade flour;
- in Afghanistan and Pakistan, data referred to the flour called Atta, which traditionally refers to high-extraction flour.
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The levels of added micronutrients to the flour in comparison with the WHO-endorsed recommendations are:

- slightly higher in Uzbekistan and Pakistan for vitamin $B_9$;
- somewhat lower in Kazakhstan and Pakistan for iron;

- somewhat lower in Kazakhstan, Tajikistan and Uzbekistan for zinc;
- other parameters in those countries comply with the recommendations of WHO;
- in Afghanistan and Kyrgyzstan, all the parameters are relevant with the WHO document.

Table 1 – WHO interim consensus statement about recommendations for fortified flours, 2009[a]**:** Average levels of nutrients to consider adding to fortified wheat flour based on extraction, fortificant compound, and estimated per capita flour availability

| Nutrient | Flour extraction rate | Compound | Level of nutrient to be added in parts per million (ppm) by estimated average per capita wheat flour availability (g/day)[b] | | | |
|---|---|---|---|---|---|---|
| | | | <75g/day[c] | 75-149 g/day | 150-300 g/day | >300g/day |
| Iron | Low | NaFeEDTA | 40 | 40 | 20 | 15 |
| | | Ferrous sulphate | 60 | 60 | 30 | 20 |
| | | Ferrous fumarate | 60 | 60 | 30 | 20 |
| | | Electrolytic iron | NR[d] | NR[d] | 60 | 40 |
| | High | NaFeEDTA | 40 | 40 | 20 | 15 |
| Folic acid | Low or high | Folic acid | 5.0 | 2.6 | 1.3 | 1.0 |
| Vitamin $B_{12}$ | Low or high | Cyanocobalamin | 0.04 | 0.02 | 0.01 | 0.008 |
| Vitamin A | Low or high | Vit A palmitate | 5.9 | 3 | 1.5 | 1 |
| Zinc[e] | Low | Zinc oxide | 95 | 55 | 40 | 30 |
| | High | Zinc oxide | 100 | 100 | 80 | 70 |

**Notes:**

[a] – WHO, FAO, UNICEF, GAIN, MI, & FFI. Recommendations on wheat and maize flour fortification. Meeting Report: Interim Consensus Statement. Geneva, World Health Organization, 2009. http://www.who.int/nutrition/publications/micronutrients/wheat_maize_fort_ru.pdf.

[b] – These estimated levels consider only wheat flour as main fortification vehicle in a public health program. If other mass-fortification programs with other food vehicles are implemented effectively, these suggested fortification levels may need to be adjusted downwards as needed.

[c] – Estimated per capita consumption of <75 g/day does not allow for addition of sufficient level of fortificant to cover micronutrients needs for women of childbearing age. Fortification of additional food vehicles and other interventions should be considered.

[d] – NR = Not Recommended because very high levels of electrolytic iron needed could negatively affect sensory properties of fortified flour.

[e] – These amounts of zinc fortification assume 5 mg zinc intake and no additional phytate intake from other dietary sources

Table 2 – Summary data on the levels of micronutrients to be added in parts per million (ppm) to fortified wheat flour according to standards in Central Asian Republics, Afghanistan and Pakistan

| Items | Kazakhstan | Kyrgyzstan | Tajikistan | Uzbekistan | Pakistan | Afghanistan |
|---|---|---|---|---|---|---|
| | premium & 1st grade [4] | premium & 1st grade [5] | premium & 1st grade [6] | 1st grade [7] | Atta [8] | Atta [9] |
| Vitamin $B_1$ | 2.0 & 1.6 | 2,0 | 2.0 & 1.6 | 1,6 | n/f | n/f |
| Vitamin $B_2$ | 3.0 & 2.4 | 3,0 | 3.0 & 2.4 | 2,4 | n/f | n/f |
| Vitamin $B_3$ | 10.0 & 8.0 | 10,0 | 10.0 & 8.0 | 8,0 | n/f | n/f |
| Vitamin $B_9$ | 1.5 & 1.2 | 1,0 | 1.5 & 1.2 | 1,2 | 1,5 | 1,0 |
| **WHO, 2009** | **1,3** | **1,0** | **1,0** | **1,0** | **1,0** | **1,0** |
| Vitamin $B_{12}$ | n/f | n/f | n/f | n/f | n/f | 0,008 |
| **WHO, 2009** | **0,01** | **0,008** | **0,008** | **0,008** | **0,008** | **0,008** |
| Iron | 50.0 & 40.0 | 15,0 | 50.0 &40.0 | 40,0 | 10,0 | 15,0 |
| **WHO, 2009** | **60,0** | **15,0** | **40,0** | **40,0** | **15,0** | **15,0** |
| | Electrolytic | Sodium Iron EDTA | Electrolytic | Electrolytic | Sodium Iron EDTA | Sodium Iron EDTA |
| Zinc | 22.0 & 17.6 | 30,0 | 22.0 &17.6 | 17,6 | n/a | 30,0 |
| **WHO, 2009** | **40,0** | **30,0** | **30,0** | **30,0** | **30,0** | **30,0** |

**Notes:**

n/f – not fortified

Wheat flour consumption in g/capita/day:

< 300 in Kazakhstan

> 300 in Afghanistan, Kyrgyzstan, Pakistan, Tajikistan and Uzbekistan

**2. Standards for mandatory and voluntary fortification of wheat flour.**

It seems to be appropriate to develop the following standards for:

- Mandatory fortification of flour with micronutrients endorsed by the World Health Organization, namely, by vitamins $B_9$ and $B_{12}$, iron and zinc for all types of flour, plus $B_1$, $B_2$ and $B_3$ for refined (low extraction) flour;
- As the high-extraction wheat flour contains good amounts of the latter vitamins ($B_1$, $B_2$ and $B_3$); those would not be added to this type of flour;
- Carry out studies of vitamin A and vitamin D deficiencies in all the countries in order to establish if the addition of these other micronutrients would be appropriate for the whole region.

**3. Setting the level of bioavailability of minerals in Afghanistan, Kazakhstan, Kyrgyzstan, Pakistan, Tajikistan and Uzbekistan.**

The Food Agriculture Organization of the United Nations/World Health Organization set iron bioavailability at 5% for a strict vegetarian diet, at 10% when some meat and ascorbic acid was added, and at 15% for diets rich in meat and fruits [10].

In our calculations, we used the following assumptions:

- The diet of the population of Kazakhstan, where the average per capita intake of wheat flour is about 250 g/day, and generous contribution of meat/poultry and vegetables/fruits can be attributed to the group with a high bioavailability (15%) of minerals.
- Other participating countries where the average per capita intake of low-extraction wheat flour is more than 300 g/day, may be referred to the group with 10% or moderate bioavailability (Kyrgyzstan, Tajikistan and Uzbekistan), and for those consuming high-extraction wheat flour as 5% or low bioavailability (Afghanistan and Pakistan). In the case of zinc, the first country would have good bioavailability (30%), and the rest moderate bioavailability (15%).

This subdivision of diet dependent levels of minerals bioavailability we took into account for calculating the levels of micronutrients in fortified flour and comparing them with vitamin and mineral requirements in human nutrition according to WHO/FAO data [11].

Our considerations are based on the average per capita consumption levels of main promoters (meat and meat products calculated per meat, vegetables and fruits) and inhibitors (cereals, which are reach in phytic acids) in the member countries (Table 3).

Table 3 – Per capita consumption of main dietary promoters and inhibitors of iron absorption in member countries*

| Promotors & inhibitors | Per capita consumption (g/day or ratio**) of main dietary promoters and inhibitors of iron absorption, by countries | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Afghanistan | | Kazakhstan | | Kyrgyzstan | | Pakistan | | Tajikistan | | Uzbekistan | |
| | g/day | ratio | g/day | ratio | g/day | ratio | g/day | ratio | g/day | ratio | g/day | ratio |
| **Promoters** | | | | | | | | | | | | |
| Meat & meat products (heme iron) | 34 | 0,2 | 191 | 1,0 | 101 | 0,5 | 45 | 0,2 | 38 | 0,2 | 93 | 0,4 |
| Vegetables (vitamin C) | 79 | 0,1 | 616 | 1,0 | 404 | 0,7 | 72 | 0,1 | 432 | 0,7 | 660 | 1,1 |
| Fruits (vitamin C) | 93 | 0,5 | 195 | 1,0 | 85 | 0,4 | 80 | 0,4 | 78 | 0,4 | 151 | 0,8 |
| Total | | **0,8** | | **3,0** | | **1,6** | | **0,8** | | **1,3** | | **2,3** |
| **Inhibitors** | | | | | | | | | | | | |
| Wheat flour | 351,2 | 13,6 | 25,9 | 1,0 | 37,8 | 1,5 | 248,8 | 9,6 | 35,0 | 1,4 | 46,7 | 1,8 |
| Milk and dairy products (calcium)? | 171 | 0,2 | 772 | 1,0 | 570 | 0,7 | 502 | 0,7 | 145 | 0,2 | 367 | 0,5 |
| Total | | **13,8** | | **2,0** | | **2,2** | | **10,3** | | **1,6** | | **2,3** |
| **Difference** (between promoters & inhibitors) | | **-13** | | **1,0** | | **-0,6** | | **-9,5** | | **-0,3** | | **0,0** |

**Notes:**

* - Adapted from reference [12]

** - with respect to indicators of Kazakhstan

Based on the data in Table 4 and literature sources [12, 13], it can be recommended to use a high (15%) of bioavailability of minerals in Kazakhstan, a moderate (10%) in Kyrgyzstan, Tajikistan and Uzbekistan, and low (5%) in Afghanistan and Pakistan.

There are other dietary promoters and inhibitors of iron absorption (Table 4). However, the data on per capita consumption for some of those promoters and inhibitors are not available.

Table 4 - Dietary promoters and inhibitors of iron absorption.

| Food and/or food compounds | Comments |
|---|---|
| **Promoters** | |
| Acid ascorbic | Present in fruits, juices and vegetables such as green leaves, peppers |
| Heme iron | Present in meat, poultry, fish and seafood (~40% of the total iron) |
| Muscle tissue, the digestion products of meat, fish or poultry | 30g of muscle has the enhancer property as 25mg of ascorbic acid, possible due to the presence of cysteine- containing peptides or a multitude of small peptides |
| Fermented or germinated food and condiments | Sauerkraut and soy sauce (cooking, fermentation, or germination of food reduces the amount of phytates) |
| Caseinophosphopeptides (CPPs) | The CPPs added to fruit beverage (grape and orange) appears to improve iron bioavailability*. |
| Polyoxycarbonic acids | Such as citrate and malate |
| **Inhibitors** | |
| Phytate or phytic acid | Present in cereal grains, high-extraction flour, legumes, and seeds |
| Polyphenols | Foods that contain the most potent inhibitors (e.g. tannins) resistant to the influence of enhancers include tea, coffee, cocoa, herbal infusions (tea) in general, certain spices (e.g. oregano), and some vegetables |
| Calcium | Particularly from milk and milk products found as calcium phosphate, inhibit absorption of non-heme and heme iron |
| Proteins | Proteins from products like milk and eggs, and albumin, casein, and soy protein (independent of the phytate content) |

**Source:**
Adapted from reference [14]

The total iron content of a diet provides little information about its content of bioavailable iron, which is considerably influenced by the foods in the diet and can vary 10-fold from different meals of similar iron content [15]. Although a vegetarian diet is likely to contain iron in amounts equivalent to amounts in a nonvegetarian diet, the iron from a vegetarian diet is likely to be substantially less available for absorption [16] because of differences in the chemical form of iron and the accompanying constituents that enhance or inhibit iron absorption [17].

The chemical form of iron is an important factor affecting the iron availability of vegetarian diets. In the diet inorganic iron-salts (non-heme) are present in plants and animal tissues, and organic iron (heme), which comes from hemoglobin (blood) and myoglobin (red muscle), is present in animal food sources. Heme-iron absorption is less affected by dietary compounds with the exception of calcium compounds [14].

Less than 40% of the iron in meat, poultry, and fish [18] is in the heme form, which is more efficiently absorbed than the remaining nonheme iron present in these and all other foods [19]. Nonvegetarian diets with substantial amounts of red meat supply about 2 mg/d, or 10–15%, of the total iron in the heme form (10). Heme iron is better absorbed (around 15–40%) than nonheme iron

(around 1–15%) [20].

Whole cereals contain phytic acids and polyphenols, which decrease iron bioavailability [21]. The phytic acid levels in low extraction wheat flour is low compared to high extraction flour. Also bread in most of the countries in CAR is fermented using yeast. Pakistan and Afghanistan have high consumption of unleavened bread made from high extraction flour. This means the phytic acid is not broken in the latter country by the fermentation step.

The fact is that the whole wheat flour (i.e. high extraction flour) is a good source of phytic acid, which is the main inhibitor of non-heme iron absorption from plant products. The phosphate groups of phytic acid are negatively charged under physiologically relevant conditions, resulting in phytate chelation of cations such as iron and zinc, making these minerals less available for absorption [22]. Consuming of phytic acid can substantially reduce iron absorption [23, 24]. Phytate content in refined (white) flour is about 100 mg/100 g, and in wheat and whole-wheat flour it is about 600 mg/100 g [25]. Polyphenols also forms insoluble complexes with iron thereby reducing its bioavailability to the body.

In addition, in Kazakhstan the consumption level of meat and meat products is much higher compared to other participating countries. The bioavailability of the heme iron from meat and meat products [26] is significantly higher (15-40%) than the bioavailability of non-heme iron from plant foods [27]. Heme-iron absorption is less affected by dietary compounds with the exception of calcium compounds [28].

The inhibitory effect of calcium on iron absorption was recognized many years ago, and the presence of large amounts of calcium can inhibit the absorption of iron from a fortified food [12]. Different studies have been conducted but they often give conflicting results because several factors influence the interaction between calcium and iron absorption [29].

Milk and dairy products are good sources of calcium. But, absorption of iron and zinc from milk products is higher than from vegetable products, even it is considered that calcium from milk and milk products found as calcium phosphate, inhibit absorption of non-heme and heme iron [14], and again there are conflicting results. For example, goat milk consumption leads to a better recovery of body Fe stores, minimizing Ca-Fe interactions and improving Fe status and its absorption [30]. The absorption of iron from the cereal-based diets was not inhibited by cow's milk [31]. On the other hand, milk contains calcium and caseins, which inhibit absorption of both non-heme and heme iron. It enters into the mucosal cells by different pathways and leave in the same form which implies that calcium inhibit the intracellular transport of iron [32].

To ensure an appropriate iron absorption, the intake of iron should be high enough to improve or maintain iron status. This condition might be attained adding sufficient iron to the fortification vehicle and/or incorporating simultaneously absorption enhancers. In the case of wheat flour fortification, the only practical enhancer to add is EDTA or using as an iron source NaFeEDTA; iron in the form of ferric sodium EDTA is 2 to 3 times more bioavailable than from other mineral sources and that it is efficiently incorporated into haemoglobin [33]; iron from ferric sodium EDTA has a high bioavailability despite the presence of inhibitory factors that form insoluble complexes [34]. Vitamin C, which can increase absorption of both native iron and fortification iron due to both its reducing power and chelating actions [35], is destroyed during baking. Bovine hemoglobin is not easily accepted or it is too expensive for being used as a fortificant.

More than half of the zinc in US diets is derived from animal foods, and one quarter of the zinc comes from beef [36]. The bioavailability of zinc from vegetarian diets is also to be less than that of nonvegetarian diets. Plant foods rich in zinc—such as legumes, whole grains, nuts, and seeds – are also high in phytic acid, an inhibitor of zinc bioavailability [37]. Bioavailability of zinc is enhanced by dietary protein [38], but plant sources of protein are also generally high in phytic acid. Because of lower absorption of zinc, those consuming vegetarian diets, especially with phytate-zinc molar ratios > 15, may require as much as 50% more zinc than nonvegetarians [39].

Thus, the iron and zinc from vegetarian diets are generally less bioavailable than from nonvegetarian diets because of reduced meat intake as well as the tendency to consume more phytic acid and other plant-based inhibitors of iron and zinc absorption.

Iron bioavailability is estimated to be around 5-12% for vegetarian diets and 14-18% for mixed diets. These values are used to generate dietary reference values for all population groups [40]. Considering all factors that may influence iron bioavailability, the estimated average absorption iron rate for a typical western diet is between 15-18% [41, 42].

**4. Premix formulation for fortification of refined wheat flour.**

In view of the above WHO recommendations, the average per capita consumption of wheat flour g/day in the participating countries, and the characteristics of diets with low and moderate bioavailability of minerals, premix composition is formulated for mandatory fortification of refined (white) flour, which is presented in Table 5.

Table 5 – The main parameters of the premix for fortification of refined wheat flour.

| Nutrient | Fortificant compound | Selected FL (mg/kg flour) | Amount of fortificant (mg/kg flour) | Premix Formulation | | | |
|---|---|---|---|---|---|---|---|
| | | | | Fortificant (g/kg premix) | Nutrient (g/kg premix) | Cost (US$/kg) | % Cost |
| Vit. B-1 (Thiamin) | Thiamin mononitrate | 2,0 | 2,5 | 9,9 | 8 | $0,25 | 2,8 |
| Vit. B-2 (Riboflavin) | Riboflavin | 3,0 | 3,0 | 12,0 | 12 | $0,72 | 8,3 |
| Vit. B-3 (Niacin) | Niacinamide | 10,0 | 10,1 | 40,4 | 40 | $0,40 | 4,7 |
| Vit. B-9 (Folate) | Folic Acid | 1,0 | 1,1 | 4,4 | 4 | $0,49 | 5,6 |
| Vit. B-12 | Vit. B-12 0.1% WS | 0,004 | 4,0 | 16,0 | 0,02 | $0,64 | 7,4 |
| Iron | NaFeEDTA | 15 | 115,4 | 461,5 | 60 | $3,00 | 34,5 |
| Zinc | Zinc oxide | 30 | 37,5 | 150,0 | 120 | $0,88 | 10,1 |
| | Filling material (at least 25%) | | 26,0 | 305,7 | | $0,31 | 3,5 |
| | | **TOTAL** | 199,6 | **1000,0** | | | |
| | Estimated cost of manufacturing, quality control and delivery (Approx. US$2/kg premix) | | | | | $2,00 | 23,0 |
| | | | Approximate Cost per kg = | | | $8,68 | 100,0 |
| | | | | | | | |
| Estimated cost of micronutrient premix per metric ton of fortified product*: | | | | | | $2,17 | |
| | | | | | | 0,43 % of the Price | |

| | |
|---|---|
| Minimum Amount (grams per MT) | 200 |
| Selected Amount (grams per MT) | 250** |

| | |
|---|---|
| Maximum Dilution Factor = 1/ | 5010 |
| Selected Dilution Factor = 1/ | 4000 |

**Notes:** Filling material: silicone dioxide or TCP (three calcium phosphate)/calcium sulphate - in an amount sufficient to free mixing. Another option of filling material: starch/calcium sulfate

* - The costs of the fortificants are always the largest cost of the fortification process, when it carried out by formal and centralized factories.

** - This value should be larger than the estimated minimum amount per metric ton (above).

**5. Establishment of production and regulatory parameters for fortification of refined wheat flour.**

Based on the composition of the premix, production and regulatory parameters for fortification of refined (white) flour are established, which are presented in Table 6.

Table 6 – The main production and regulatory parameters for fortification of refined wheat flour

| Nutrient | Fortificant compound | Selected FL (mg/kg flour) | Production Parameters | | | Regulatory Parameters | |
|---|---|---|---|---|---|---|---|
| | | | mFL (1) (mg/kg flour) | Average (2) (mg/kg flour) | MFL (3) (mg/kg flour) | LmL (4) (mg/kg flour) | MTL (5) (mg/kg flour) |
| Vit. B-1 (Thiamin) | Thiamin mononitrate | 2,0 | 1,5 | 2,8 | 4,1 | 1,3 | 4,1 |
| Vit. B-2 (Riboflavin) | Riboflavin | 3,0 | 2,0 | 3,6 | 5,2 | 1,8 | 5,2 |
| Vit. B-3 (Niacin) | Niacinamide | 10,0 | 11,0 | 20,0 | 29,0 | 9,9 | 29,0 |
| Vit. B-9 (Folate) | Folic Acid | 1,0 | 0,7 | 1,3 | 1,9 | 0,6 | 1,9 |
| Vit. B-12 | Vit. B-12 0.1% WS | 0,004 | 0,002 | 0,004 | 0,006 | 0,002 | 0,006 |
| Iron | NaFeEDTA (7) | 15 | 16 | 24 | 32 | 16 | 32 |
| Zinc | Zinc oxide | 30 | 26 | 38 | 50 | 26 | 50 |

**Notes:**
(1) mFL = Minimum Fortification Level, using equation 2.
(2) Average = Selected Fortification Level + Intrinsic content of micronutrient in unfortified food.
(3) MFL = Maximum Fortification Level, using equation 3.
(4) LmL= Legal Minimum Level, using equation 4.
(5) MTL = Maximum Tolerable Level, equivalent to MFL but only for those micronutrients with safety concerns, and rounded.
(6) As the iron from ferrous sulfate is very difficult to measure independently from intrinsic iron, as well as from NafeEDTA, because the usual analytical methods require ashing of the sample, the expected total iron amount is presented here (i.e. intrinsic iron + iron from NaFeEDTA + iron from ferrous sulfate).
(7) As the iron from NaFeEDTA can be determined separated of the intrinsic iron (and perhaps the iron from ferrous sulfate), these values are only expressing the variation of the content of iron coming from NaFeEDTA.

**6. Daily intake of micronutrients by population groups in the composition of fortified wheat flour, by countries, in % EAR/day.**

**Terms** [43]**:**

EAR = Estimated Average Requirement is the daily intake which meets the nutrient requirements of 50% apparently healthy individuals in an age- and sex-specific population.

RNI = Recommended nutrient intake is the daily intake which meets the nutrient requirements of almost all (97.5%) apparently healthy individuals in an age- and sex-specific population.

All basic calculations in this and other sections are conducted using the Formulator, developed by Omar Dary и Michael Hainsworth [44].

In terms of daily **vitamin $B_1$ (thiamin)** intake in the composition of fortified wheat flour, in % EAR/day, in all population groups (Table 7) the participating countries are located in the following ascending order:

- Kazakhstan: 27% to 35% in different age and gender groups
- Pakistan: 32 to 42%
- Tajikistan: 36% to 47%
- Kyrgyzstan: 39% to 51%
- Afghanistan: 45% to 59%
- Uzbekistan: 48% to 63%.

So, the value of this indicator is correlated with an average per capita consumption of wheat flour in g/day, which was the smallest in Kazakhstan and the largest in Uzbekistan.

In terms of daily **vitamin $B_2$ (riboflavin)** intake in the composition of fortified wheat flour, in % EAR/day, in all population groups the participating countries are located in the following ascending order:

- Kazakhstan: 50% to 66% in different age and gender groups
- Pakistan: 60% to 78%
- Tajikistan: 68% to 88%
- Kyrgyzstan: 73% to 94%
- Afghanistan: 85% to 110%
- Uzbekistan: 90% to 117%.

The value of this indicator is correlated with an average per capita consumption of wheat flour in g/day, which was the smallest in Kazakhstan and the largest in Uzbekistan, as well.

In terms of daily **vitamin $B_3$ (niacin)** intake in the composition of fortified wheat flour, in % EAR/day, in all population groups the participating countries are located in the following ascending order:

- Kazakhstan: 14% to 18% in different age and gender groups
- Pakistan: 17% to 22%
- Tajikistan: 19% to 24%
- Kyrgyzstan: 20% to 26%
- Afghanistan: 23% to 30%
- Uzbekistan: 25% to 32%.

Again, the value of this indicator is correlated with an average per capita consumption of wheat flour in g/day, which was the smallest in Kazakhstan and the largest in Uzbekistan.

That is, that the value of this indicator is correlated with an average per capita consumption of wheat flour in g/day, which was the smallest in Kazakhstan and the largest in Uzbekistan.

In terms of daily **folic acid** intake in the composition of fortified wheat flour, in % EAR/day, in all population groups the participating countries are located in the following ascending order:

- Kazakhstan: 79% to 113% in different age and gender groups
- Pakistan: 96% to 136%
- Tajikistan: 108% to 154%
- Kyrgyzstan: 116% to 166%

- Afghanistan: 135% to 192%
- Uzbekistan: 240% to 205%.

So, the value of this indicator is correlated with an average per capita consumption of wheat flour in g/day, which was the smallest in Kazakhstan and the largest in Uzbekistan.

In a similar manner the participating countries are arranged by the level of daily intake of added **vitamin $B_{12}$** in % EAR/day:

- Kazakhstan: 31% to 47%
- Pakistan: 37% to 57%
- Tajikistan: 42% to 64%
- Kyrgyzstan: 45% to 69%
- Afghanistan: 52% to 80%
- Uzbekistan: 56% to 85%.

Unlike vitamins, by the level of daily **iron** intake in the composition of fortified wheat flour, in % EAR/day, for all groups of population, the participating countries are located in the following ascending order:

- Pakistan: 21% to 85%
- Afghanistan: 30% to 120%
- Tajikistan: 36% to 143%
- Kyrgyzstan: 39% to 154%
- Kazakhstan: 39% to 158%
- Uzbekistan: 48% to 191%.

That is, that the value of this indicator is also correlated with an average per capita consumption of wheat flour in g/day, with the exception of Kazakhstan, where the value of the index was higher than in Pakistan, Afghanistan, Tajikistan and Kyrgyzstan, but lower than in Uzbekistan. This is because the average diet in Kazakhstan attributed, as mentioned above, to the group with a high bioavailability of minerals and the diet of other participating countries - to the group with a moderate (Kyrgyzstan, Tajikistan and Uzbekistan) low (Afghanistan and Pakistan) bioavailability of minerals.

In terms of daily **zinc** intake in the composition of fortified wheat flour, in % EAR/day, in all population groups the participating countries are located in the following ascending order:

- Pakistan: 50% to 90%
- Afghanistan: 71% to 127%
- Kazakhstan: 84% to 150%.
- Tajikistan: 114% to 203%
- Kyrgyzstan: 123% to 219%
- Uzbekistan: 152% to 271%

Table 7 – Daily intake of micronutrients by population groups in the composition of fortified wheat flour, by countries, in % EAR/day

| Nutrient | Additional daily intake of nutrients by countries population groups, in %EAR/day | | | | | |
|---|---|---|---|---|---|---|
| | Afghanistan | Kazakhstan | Kyrgyzstan | Pakistan | Tajikistan | Uzbekistan |
| **Children, 1-3 years** | | | | | | |
| Vit. B-1 (Thiamin) | 54,8 | 32,3 | 47,2 | 38,9 | 43,7 | 58,4 |
| Vit. B-2 (Riboflavin) | 103,5 | 61,0 | 89,1 | 73,4 | 82,6 | 110,2 |
| Vit. B-3 (Niacin) | 29,9 | 17,6 | 25,8 | 21,2 | 23,9 | 31,8 |
| Vit. B-9 (Folate) | 189,8 | 111,9 | 163,4 | 134,6 | 151,5 | 202,1 |
| Vit. B-12 | 79,8 | 47,0 | 68,7 | 56,6 | 63,7 | 84,9 |

| Nutrient | Additional daily intake of nutrients by countries population groups, in %EAR/day | | | | | |
|---|---|---|---|---|---|---|
| | Afghanistan | Kazakhstan | Kyrgyzstan | Pakistan | Tajikistan | Uzbekistan |
| Iron (NaFeEDTA) | 97,9 | 129,8 | 126,4 | 69,4 | 117,2 | 156,3 |
| Zinc | 70,5 | 84,0 | 122,8 | 50,0 | 113,8 | 151,8 |
| **Children, 4-6 years** | | | | | | |
| Vit. B-1 (Thiamin) | 58,0 | 34,2 | 50,0 | 41,1 | 46,3 | 61,8 |
| Vit. B-2 (Riboflavin) | 109,6 | 64,6 | 94,4 | 77,7 | 87,5 | 116,7 |
| Vit. B-3 (Niacin) | 28,5 | 16,8 | 24,5 | 20,2 | 22,7 | 30,3 |
| Vit. B-9 (Folate) | 180,9 | 106,6 | 155,7 | 128,3 | 144,3 | 192,5 |
| Vit. B-12 | 70,2 | 41,4 | 60,4 | 49,8 | 56,0 | 74,7 |
| Iron (NaFeEDTA) | 119,4 | 158,3 | 154,1 | 84,7 | 142,9 | 190,6 |
| Zinc | 77,4 | 91,2 | 133,2 | 54,9 | 123,5 | 164,7 |
| **Children, 7-9 years** | | | | | | |
| Vit. B-1 (Thiamin) | 48,6 | 28,6 | 41,8 | 34,4 | 38,8 | 51,7 |
| Vit. B-2 (Riboflavin) | 91,7 | 54,1 | 79,0 | 65,0 | 73,2 | 97,6 |
| Vit. B-3 (Niacin) | 23,9 | 14,1 | 20,5 | 16,9 | 19,0 | 25,4 |
| Vit. B-9 (Folate) | 151,4 | 89,2 | 130,3 | 107,3 | 120,8 | 161,1 |
| Vit. B-12 | 58,7 | 34,6 | 50,6 | 41,7 | 46,9 | 62,5 |
| Iron (NaFeEDTA) | 106,1 | 140,6 | 137,0 | 75,2 | 127,0 | 169,4 |
| Zinc | 83,3 | 98,1 | 143,3 | 59,0 | 132,9 | 177,2 |
| **Males, 10-18 years** | | | | | | |
| Vit. B-1 (Thiamin) | 54,5 | 32,1 | 46,9 | 38,7 | 43,5 | 58,0 |
| Vit. B-2 (Riboflavin) | 95,1 | 56,0 | 81,8 | 67,4 | 75,9 | 101,2 |
| Vit. B-3 (Niacin) | 27,9 | 16,4 | 24,0 | 19,8 | 22,3 | 29,7 |
| Vit. B-9 (Folate) | 177,0 | 104,3 | 152,4 | 125,5 | 141,2 | 188,4 |
| Vit. B-12 | 68,7 | 40,5 | 59,1 | 48,7 | 54,8 | 73,1 |
| Iron (NaFeEDTA) | 48,5 | 64,3 | 60,8 | 34,4 | 56,4 | 75,2 |
| Zinc | 85,0 | 99,6 | 145,5 | 60,3 | 134,9 | 180,0 |
| **Males, 19-50 years** | | | | | | |
| Vit. B-1 (Thiamin) | 59,3 | 34,9 | 51,0 | 42,0 | 47,3 | 63,1 |
| Vit. B-2 (Riboflavin) | 103,3 | 60,9 | 89,0 | 73,3 | 82,5 | 110,0 |
| Vit. B-3 (Niacin) | 30,3 | 17,9 | 26,1 | 21,5 | 24,2 | 32,3 |

| Nutrient | Additional daily intake of nutrients by countries population groups, in %EAR/day | | | | | |
|---|---|---|---|---|---|---|
| | Afghanistan | Kazakhstan | Kyrgyzstan | Pakistan | Tajikistan | Uzbekistan |
| Vit. B-9 (Folate) | 192,4 | 113,4 | 165,6 | 136,4 | 153,5 | 204,8 |
| Vit. B-12 | 74,7 | 44,0 | 64,3 | 52,9 | 59,6 | 79,5 |
| Iron (NaFeEDTA) | 63,9 | 84,8 | 82,5 | 45,3 | 76,5 | 102,1 |
| Zinc | 112,9 | 133,0 | 194,3 | 80,0 | 180,2 | 240,3 |
| **Males, 51-65 years** | | | | | | |
| Vit. B-1 (Thiamin) | 58,1 | 34,2 | 50,0 | 41,2 | 46,3 | 61,8 |
| Vit. B-2 (Riboflavin) | 101,3 | 59,7 | 87,2 | 71,8 | 80,8 | 107,8 |
| Vit. B-3 (Niacin) | 29,7 | 17,5 | 25,6 | 21,1 | 23,7 | 31,6 |
| Vit. B-9 (Folate) | 188,6 | 111,1 | 162,3 | 133,7 | 150,5 | 200,7 |
| Vit. B-12 | 73,2 | 43,1 | 63,0 | 51,9 | 58,4 | 77,9 |
| Iron (NaFeEDTA) | 62,6 | 83,1 | 80,9 | 44,4 | 75,0 | 100,0 |
| Zinc | 110,6 | 130,4 | 190,5 | 78,4 | 176,6 | 235,5 |
| **Males, +65 years** | | | | | | |
| Vit. B-1 (Thiamin) | 48,6 | 28,6 | 41,8 | 34,5 | 38,8 | 51,7 |
| Vit. B-2 (Riboflavin) | 84,7 | 49,9 | 72,9 | 60,1 | 67,6 | 90,2 |
| Vit. B-3 (Niacin) | 24,9 | 14,7 | 21,4 | 17,6 | 19,8 | 26,5 |
| Vit. B-9 (Folate) | 157,8 | 93,0 | 135,8 | 111,9 | 125,9 | 167,9 |
| Vit. B-12 | 61,2 | 36,1 | 52,7 | 43,4 | 48,9 | 65,2 |
| Iron (NaFeEDTA) | 52,4 | 69,5 | 67,7 | 37,2 | 62,7 | 83,7 |
| Zinc | 92,6 | 109,1 | 159,4 | 65,6 | 147,7 | 197,1 |
| **Females, 10-18 years** | | | | | | |
| Vit. B-1 (Thiamin) | 49,8 | 29,3 | 42,9 | 35,3 | 39,7 | 53,0 |
| Vit. B-2 (Riboflavin) | 94,8 | 55,9 | 81,6 | 67,2 | 75,7 | 100,9 |
| Vit. B-3 (Niacin) | 23,3 | 13,8 | 20,1 | 16,6 | 18,6 | 24,9 |
| Vit. B-9 (Folate) | 148,2 | 87,3 | 127,5 | 105,1 | 118,2 | 157,7 |
| Vit. B-12 | 57,5 | 33,9 | 49,5 | 40,8 | 45,9 | 61,2 |
| Iron (NaFeEDTA) | 29,6 | 39,3 | 38,9 | 21,0 | 36,0 | 48,1 |
| Zinc | 84,5 | 99,6 | 145,5 | 59,9 | 134,9 | 179,9 |
| **Females, 19-50 years** | | | | | | |
| Vit. B-1 (Thiamin) | 51,1 | 30,1 | 44,0 | 36,2 | 40,8 | 54,4 |
| Vit. B-2 | 96,5 | 56,9 | 83,0 | 68,4 | 77,0 | 102,7 |

| Nutrient | Additional daily intake of nutrients by countries population groups, in %EAR/day | | | | | |
|---|---|---|---|---|---|---|
| | Afghanistan | Kazakhstan | Kyrgyzstan | Pakistan | Tajikistan | Uzbekistan |
| (Riboflavin) | | | | | | |
| Vit. B-3 (Niacin) | 27,4 | 16,1 | 23,6 | 19,4 | 21,8 | 29,1 |
| Vit. B-9 (Folate) | 152,0 | 89,6 | 130,8 | 107,8 | 121,3 | 161,8 |
| Vit. B-12 | 59,0 | 34,8 | 50,8 | 41,8 | 47,1 | 62,8 |
| Iron (NaFeEDTA) | 39,3 | 52,1 | 50,7 | 27,9 | 47,0 | 62,7 |
| Zinc | 127,4 | 150,2 | 219,3 | 90,3 | 203,3 | 271,2 |
| **Females, 51-65 years** | | | | | | |
| Vit. B-1 (Thiamin) | 51,1 | 29,7 | 43,4 | 35,8 | 40,2 | 53,7 |
| Vit. B-2 (Riboflavin) | 96,5 | 56,1 | 82,0 | 67,5 | 76,0 | 101,4 |
| Vit. B-3 (Niacin) | 27,4 | 15,9 | 23,3 | 19,2 | 21,6 | 28,8 |
| Vit. B-9 (Folate) | 150,1 | 88,4 | 129,2 | 106,4 | 119,8 | 159,8 |
| Vit. B-12 | 58,2 | 34,3 | 50,1 | 41,3 | 46,5 | 62,0 |
| Iron (NaFeEDTA) | 100,9 | 133,8 | 130,3 | 71,6 | 120,8 | 161,1 |
| Zinc | 125,8 | 148,3 | 216,6 | 89,2 | 200,7 | 267,8 |
| **Females, +65 years** | | | | | | |
| Vit. B-1 (Thiamin) | 45,3 | 26,7 | 39,0 | 32,1 | 36,1 | 48,2 |
| Vit. B-2 (Riboflavin) | 85,5 | 50,4 | 73,6 | 60,6 | 68,2 | 91,0 |
| Vit. B-3 (Niacin) | 24,3 | 14,3 | 20,9 | 17,2 | 19,4 | 25,8 |
| Vit. B-9 (Folate) | 134,7 | 79,4 | 115,9 | 95,5 | 107,5 | 143,4 |
| Vit. B-12 | 52,3 | 30,8 | 45,0 | 37,1 | 41,7 | 55,6 |
| Iron (NaFeEDTA) | 65,3 | 86,5 | 84,3 | 46,3 | 78,1 | 104,2 |
| Zinc | 112,9 | 133,0 | 194,3 | 80,0 | 180,2 | 240,3 |

**Note:**

EAR = Estimated Average Requirement is the daily intake which meets the nutrient requirements of 50% apparently healthy individuals in an age- and sex-specific population.

**7. Daily intake of micronutrients by population groups in the composition of fortified wheat flour, by countries, in % RNI/day.**

In terms of total daily **vitamin $B_1$ (thiamin)** intake groups in the composition of fortified wheat flour, in % RNI/day, in all population groups (Table 8) the participating countries are located in the following ascending order:

- Kazakhstan: 22% to 29% in different age and gender groups
- Pakistan: 28% to 35%
- Tajikistan: 30% to 39%
- Kyrgyzstan: 33% to 43%
- Afghanistan: 38% to 49%
- Uzbekistan: 40% to 53%.

The value of this indicator is correlated with an average per capita consumption of wheat flour in g/day, which is the smallest in Kazakhstan and the largest in Uzbekistan.

In terms of total daily **vitamin $B_2$ (riboflavin)** intake groups in the composition of fortified wheat flour, in % RNI/day, in all population groups (Table 8) the participating countries are located in the following ascending order:

- Kazakhstan: 42% to 52% in different age and gender groups
- Pakistan: 50% to 62%
- Tajikistan: 56% to 70%
- Kyrgyzstan: 61% to 76%
- Afghanistan: 71% to 88%
- Uzbekistan: 75% to 93%.

The value of this indicator is correlated with an average per capita consumption of wheat flour in g/day, which is the smallest in Kazakhstan and the largest in Uzbekistan, as well.

The value of this indicator is correlated with an average per capita consumption of wheat flour in g/day, which is the smallest in Kazakhstan and the largest in Uzbekistan.

In terms of total daily **vitamin $B_3$ (niacin)** intake groups in the composition of fortified wheat flour, in % RNI/day, in all population groups (Table 8) the participating countries are located in the following ascending order:

- Kazakhstan: 11% to 14% in different age and gender groups
- Pakistan: 13% to 17%
- Tajikistan: 14% to 19%
- Kyrgyzstan: 16% to 20%
- Afghanistan: 18% to 23%
- Uzbekistan: 19% to 25%.

The value of this indicator is correlated with an average per capita consumption of wheat flour in g/day, which is the smallest in Kazakhstan and the largest in Uzbekistan, as well.

In a similar manner, the participating countries are arranged by the levels of total daily intake In terms of total daily **folic acid** intake groups in the composition of fortified wheat flour, in % RNI/day, in all population groups (Table 8) the participating countries are located in the following ascending order:

- Kazakhstan: 64% to 91% in different age and gender groups
- Pakistan: 76% to 109%
- Tajikistan: 86% to 123%
- Kyrgyzstan: 93% to 133%
- Afghanistan: 108% to 156%
- Uzbekistan: 115% to 164%.

That is, that the value of this indicator is correlated with an average per capita consumption of wheat flour in g/day, which is the smallest in Kazakhstan and the largest in Uzbekistan.

In a similar manner, the participating countries are arranged by the levels of total daily intake of **vitamin $B_{12}$**, in % RNI/day:

- Kazakhstan: 26% to 37%
- Pakistan: 31% to 44%
- Tajikistan: 35% to 50%
- Kyrgyzstan: 38% to 54%
- Afghanistan: 44% to 62%
- Uzbekistan: 46% to 66%.

Unlike vitamins, by the level of total daily intake of **iron,** in % RNI/day, for all groups of population, the participating countries are located in the following ascending order:

- Pakistan: 11% to 35%
- Afghanistan: 16% to 49%
- Tajikistan: 19% to 59%
- Kyrgyzstan: 21% to 63%
- Kazakhstan: 21% to 65%
- Uzbekistan: 25% to 78%.

That is, that the value of this indicator is also correlated with an average per capita consumption of wheat flour in g/day, with the exception of Kazakhstan, where the value of the index was slightly higher than in Pakistan, Afghanistan, Tajikistan and Kyrgyzstan, but lower than in Uzbekistan. This is because the average diet in Kazakhstan attributed, as mentioned above, to the group with a high bioavailability of minerals and the diet of other participating countries - to the group with a moderate (Kyrgyzstan, Tajikistan and Uzbekistan) and low (Afghanistan and Pakistan) bioavailability of minerals.

In terms of total daily **zinc** intake, in % RNI/day, in all population groups the participating countries are located in the following ascending order:

- Pakistan: 41% to 75%
- Afghanistan: 59% to 106%
- Kazakhstan: 70% to 125%.
- Tajikistan: 95% to 169%
- Kyrgyzstan: 102% to 183%
- Uzbekistan: 127% to 226%

Table 8 – Daily intake of micronutrients by population groups in the composition of fortified wheat flour, by countries, in % RNI/day

| Nutrient | Total daily intake of nutrients by countries population groups, in % RNI/day | | | | | |
|---|---|---|---|---|---|---|
| | Afghanistan | Kazakhstan | Kyrgyzstan | Pakistan | Tajikistan | Uzbekistan |
| **Children, 1-3 years** | | | | | | |
| Vit. B-1 (Thiamin) | 43,9 | 25,8 | 37,8 | 31,1 | 35,0 | 46,7 |
| Vit. B-2 (Riboflavin) | 82,8 | 48,8 | 71,3 | 58,7 | 66,1 | 88,2 |
| Vit. B-3 (Niacin) | 23,0 | 13,6 | 19,8 | 16,3 | 18,4 | 24,5 |
| Vit. B-9 (Folate) | 151,9 | 89,5 | 130,7 | 107,7 | 121,2 | 161,7 |
| Vit. B-12 | 61,4 | 36,2 | 52,8 | 43,5 | 49,0 | 65,3 |
| Iron (NaFeEDTA) | 42,0 | 55,7 | 54,2 | 29,8 | 50,3 | 67,1 |
| Zinc | 58,7 | 70,0 | 102,3 | 41,6 | 94,8 | 126,5 |
| **Children, 4-6 years** | | | | | | |
| Vit. B-1 | 46,4 | 27,4 | 40,0 | 32,9 | 37,0 | 49,4 |

| Nutrient | Total daily intake of nutrients by countries population groups, in % RNI/day | | | | | |
|---|---|---|---|---|---|---|
| | Afghanistan | Kazakhstan | Kyrgyzstan | Pakistan | Tajikistan | Uzbekistan |
| (Thiamin) | | | | | | |
| Vit. B-2 (Riboflavin) | 87,7 | 51,7 | 75,5 | 62,2 | 70,0 | 93,3 |
| Vit. B-3 (Niacin) | 21,9 | 12,9 | 18,9 | 15,5 | 17,5 | 23,3 |
| Vit. B-9 (Folate) | 144,7 | 85,3 | 124,6 | 102,6 | 115,5 | 154,0 |
| Vit. B-12 | 58,5 | 34,5 | 50,3 | 41,5 | 46,7 | 62,3 |
| Iron (NaFeEDTA) | 49,1 | 65,1 | 63,4 | 34,8 | 58,8 | 78,4 |
| Zinc | 64,5 | 76,0 | 111,0 | 45,7 | 102,9 | 137,3 |
| **Children, 7-9 years** | | | | | | |
| Vit. B-1 (Thiamin) | 38,9 | 22,9 | 33,4 | 27,6 | 31,0 | 41,4 |
| Vit. B-2 (Riboflavin) | 73,4 | 43,2 | 63,2 | 52,0 | 58,6 | 78,1 |
| Vit. B-3 (Niacin) | 18,3 | 10,8 | 15,8 | 13,0 | 14,6 | 19,5 |
| Vit. B-9 (Folate) | 121,1 | 71,4 | 104,2 | 85,9 | 96,6 | 128,9 |
| Vit. B-12 | 48,9 | 28,9 | 42,1 | 34,7 | 39,1 | 52,1 |
| Iron (NaFeEDTA) | 43,7 | 57,9 | 56,4 | 31,0 | 52,2 | 69,7 |
| Zinc | 69,4 | 81,8 | 119,4 | 49,2 | 110,7 | 147,7 |
| **Males, 10-18 years** | | | | | | |
| Vit. B-1 (Thiamin) | 45,4 | 26,8 | 39,1 | 32,2 | 36,3 | 48,4 |
| Vit. B-2 (Riboflavin) | 79,2 | 46,7 | 68,2 | 56,2 | 63,2 | 84,3 |
| Vit. B-3 (Niacin) | 21,5 | 12,6 | 18,5 | 15,2 | 17,1 | 22,8 |
| Vit. B-9 (Folate) | 141,6 | 83,5 | 121,9 | 100,4 | 113,0 | 150,7 |
| Vit. B-12 | 57,2 | 33,7 | 49,3 | 40,6 | 45,7 | 60,9 |
| Iron (NaFeEDTA) | 34,6 | 45,9 | 43,5 | 24,5 | 40,3 | 53,7 |
| Zinc | 70,9 | 83,0 | 121,3 | 50,2 | 112,4 | 150,0 |
| **Males, 19-50 years** | | | | | | |
| Vit. B-1 (Thiamin) | 49,4 | 29,1 | 42,5 | 35,0 | 39,4 | 52,6 |
| Vit. B-2 (Riboflavin) | 86,1 | 50,7 | 74,1 | 61,1 | 68,7 | 91,7 |
| Vit. B-3 (Niacin) | 23,3 | 13,7 | 20,1 | 16,5 | 18,6 | 24,8 |
| Vit. B-9 (Folate) | 153,9 | 90,7 | 132,5 | 109,1 | 122,8 | 163,8 |
| Vit. B-12 | 62,2 | 36,7 | 53,6 | 44,1 | 49,7 | 66,2 |
| Iron (NaFeEDTA) | 48,1 | 63,7 | 62,1 | 34,1 | 57,5 | 76,7 |

| Nutrient | Total daily intake of nutrients by countries population groups, in % RNI/day | | | | | |
|---|---|---|---|---|---|---|
| | Afghanistan | Kazakhstan | Kyrgyzstan | Pakistan | Tajikistan | Uzbekistan |
| Zinc | 94,1 | 110,9 | 162,0 | 66,7 | 150,1 | 200,3 |
| **Males, 51-65 years** | | | | | | |
| Vit. B-1 (Thiamin) | 48,4 | 28,5 | 41,7 | 34,3 | 38,6 | 51,5 |
| Vit. B-2 (Riboflavin) | 84,4 | 49,7 | 72,6 | 59,8 | 67,3 | 89,8 |
| Vit. B-3 (Niacin) | 22,9 | 13,5 | 19,7 | 16,2 | 18,2 | 24,3 |
| Vit. B-9 (Folate) | 150,8 | 88,9 | 129,9 | 107,0 | 120,4 | 160,6 |
| Vit. B-12 | 61,0 | 35,9 | 52,5 | 43,2 | 48,7 | 64,9 |
| Iron (NaFeEDTA) | 47,1 | 62,5 | 60,8 | 33,4 | 56,4 | 75,2 |
| Zinc | 92,2 | 108,7 | 158,7 | 65,4 | 147,1 | 196,3 |
| **Males, +65 years** | | | | | | |
| Vit. B-1 (Thiamin) | 40,5 | 23,9 | 34,9 | 28,7 | 32,3 | 43,1 |
| Vit. B-2 (Riboflavin) | 70,6 | 41,6 | 60,8 | 50,1 | 56,3 | 75,2 |
| Vit. B-3 (Niacin) | 19,1 | 11,3 | 16,5 | 13,6 | 15,3 | 20,4 |
| Vit. B-9 (Folate) | 126,2 | 74,4 | 108,7 | 89,5 | 100,7 | 134,4 |
| Vit. B-12 | 51,0 | 30,1 | 43,9 | 36,2 | 40,7 | 54,3 |
| Iron (NaFeEDTA) | 39,4 | 52,3 | 50,9 | 27,9 | 47,2 | 62,9 |
| Zinc | 77,1 | 90,9 | 132,8 | 54,7 | 123,1 | 164,2 |
| **Females, 10-18 years** | | | | | | |
| Vit. B-1 (Thiamin) | 41,5 | 24,4 | 35,7 | 29,4 | 33,1 | 44,2 |
| Vit. B-2 (Riboflavin) | 86,2 | 50,8 | 74,2 | 61,1 | 68,8 | 91,8 |
| Vit. B-3 (Niacin) | 18,0 | 10,6 | 15,5 | 12,7 | 14,3 | 19,1 |
| Vit. B-9 (Folate) | 118,5 | 69,8 | 102,0 | 84,0 | 94,6 | 126,2 |
| Vit. B-12 | 47,9 | 28,2 | 41,2 | 34,0 | 38,2 | 51,0 |
| Iron (NaFeEDTA) | 15,6 | 20,7 | 20,5 | 11,1 | 19,0 | 25,3 |
| Zinc | 70,4 | 83,0 | 121,2 | 49,9 | 112,4 | 149,9 |
| **Females, 19-50 years** | | | | | | |
| Vit. B-1 (Thiamin) | 42,6 | 25,1 | 36,6 | 30,2 | 34,0 | 45,3 |
| Vit. B-2 (Riboflavin) | 80,4 | 47,4 | 69,2 | 57,0 | 64,2 | 85,6 |
| Vit. B-3 (Niacin) | 21,1 | 12,4 | 18,1 | 14,9 | 16,8 | 22,4 |
| Vit. B-9 (Folate) | 121,6 | 71,7 | 104,7 | 86,2 | 97,0 | 129,4 |

| Nutrient | Total daily intake of nutrients by countries population groups, in % RNI/day | | | | | |
|---|---|---|---|---|---|---|
| | Afghanistan | Kazakhstan | Kyrgyzstan | Pakistan | Tajikistan | Uzbekistan |
| Vit. B-12 | 49,2 | 29,0 | 42,3 | 34,9 | 39,2 | 52,3 |
| Iron (NaFeEDTA) | 17,7 | 23,5 | 22,8 | 12,5 | 21,2 | 28,3 |
| Zinc | 106,2 | 125,1 | 182,8 | 75,3 | 169,4 | 226,0 |
| **Females, 51-65 years** | | | | | | |
| Vit. B-1 (Thiamin) | 42,6 | 24,8 | 36,2 | 29,8 | 33,5 | 44,7 |
| Vit. B-2 (Riboflavin) | 80,4 | 46,8 | 68,3 | 56,3 | 63,3 | 84,5 |
| Vit. B-3 (Niacin) | 21,1 | 12,3 | 17,9 | 14,7 | 16,6 | 22,1 |
| Vit. B-9 (Folate) | 120,1 | 70,8 | 103,4 | 85,1 | 95,8 | 127,8 |
| Vit. B-12 | 48,5 | 28,6 | 41,8 | 34,4 | 38,7 | 51,7 |
| Iron (NaFeEDTA) | 45,5 | 60,3 | 58,7 | 32,2 | 54,4 | 72,6 |
| Zinc | 104,8 | 123,5 | 180,5 | 74,3 | 167,3 | 223,2 |
| **Females, +65 years** | | | | | | |
| Vit. B-1 (Thiamin) | 37,7 | 22,2 | 32,5 | 26,7 | 30,1 | 40,1 |
| Vit. B-2 (Riboflavin) | 71,2 | 42,0 | 61,3 | 50,5 | 56,8 | 75,8 |
| Vit. B-3 (Niacin) | 18,7 | 11,0 | 16,1 | 13,2 | 14,9 | 19,9 |
| Vit. B-9 (Folate) | 107,7 | 63,5 | 92,8 | 76,4 | 86,0 | 114,7 |
| Vit. B-12 | 43,6 | 25,7 | 37,5 | 30,9 | 34,8 | 46,4 |
| Iron (NaFeEDTA) | 40,8 | 54,1 | 52,7 | 28,9 | 48,8 | 65,1 |
| Zinc | 94,1 | 110,9 | 162,0 | 66,7 | 150,1 | 200,3 |

**Note:**

RNI = Recommended nutrient intake is the daily intake which meets the nutrient requirements of almost all (97.5%) apparently healthy individuals in an age- and sex-specific population.

**8. Brief description of the annexes.**

Annexes 1-6 provide detailed characteristics of fortified refined (white) wheat flour using a premix, the main parameters of which are shown in Table 5. In particular, the following data are given in these annexes:

- Addition levels each of seven micronutrients (vitamins $B_1$, $B_2$, $B_3$, $B_9$ and $B_{12}$, iron as NaFeEDTA, and zinc) to flour, in mg/kg flour
- Adjusted upper limit for each of the micronutrients (vitamins $B_1$, $B_2$, $B_3$, $B_9$ and $B_{12}$, iron as NaFeEDTA, and zinc), in mg/kg flour
- Daily intake of micronutrients in the composition of fortified wheat flour, in:
    - mg/day
    - % EAR/day
    - % RNI/day

The mentioned information in each member country are presented for the following age and gender groups of population in accordance with WHO recommendations:

1. Children, 1-3 years
2. Children, 4-6 years
3. Children, 7-9 years
4. Males, 10-18 years
5. Males, 19-50 years
6. Males, 51-65 years
7. Males, + 65 years
8. Females, 10-18 years
9. Females, 19-50 years
10. Females, 51-65 years
11. Females, + 65 years

Total 6 annexes are drawn up by the number of countries:

- Afghanistan – Annex 1
- Kazakhstan – Annex 1
- Kyrgyzstan – Annex 1
- Pakistan – Annex 1
- Tajikistan – Annex 1
- Uzbekistan – Annex 1

**9. Conclusion.**

1. For the mandatory fortification of refined (white) wheat flour the following 7 micronutrients are selected:

- Vitamin $B_1$ (thiamin)
- Vitamin $B_2$ (riboflavin)
- Vitamin $B_9$ (niacin)
- Vitamin $B_9$ (folate)
- Vitamin $B_{12}$ (cyanocobalamin)
- Iron (NaFeEDTA)
- Zinc (zinc oxide)

2. The proposed addition levels of micronutrients in refined flour:

- prepared taking into account the average per capita consumption of flour (in g/day) in the participating countries;
- fully comply with WHO recommendations

3. The proposed levels of refined flour fortification by **zinc and vitamins $B_1$, $B_2$, $B_3$, $B_9$ and $B_{12}$** ensure the following levels of total daily intake (in % RNI/day) of these micronutrients in the composition of refined fortified wheat flour for all population groups in participating countries:

| Nutrient | Total daily intake of nutrients by countries population groups, in % RNI/day | | | | | |
|---|---|---|---|---|---|---|
| | Afghanistan | Kazakhstan | Kyrgyzstan | Pakistan | Tajikistan | Uzbekistan |
| Vit. B-3 (Niacin) | 18% to 23% | 11% to 14% | 16% to 20% | 13% to 17% | 14% to 19% | 19% to 25% |
| Vit. B-1 (Thiamin) | 38% to 49% | 22% to 29% | 33% to 43% | 28% to 35% | 30% to 39% | 40% to 53% |
| Vit. B-2 (Ribiflavin) | 71% to 88% | 42% to 52% | 61% to 76% | 50% to 62% | 56% to 70% | 75% to 93% |
| Vit. B-12 | 44% to 62% | 26% to 37% | 38% to 54% | 31% to 44% | 35% to 50% | 46% to 66% |
| Vit. B-9 (Folate) | 108% to 156% | 64% to 91% | 93% to 133% | 76% to 109% | 86% to 123% | 115% to 164% |
| Zinc | 59% to 106% | 70% to 125% | 102% to 183% | 41% to 75% | 95% to 169% | 127% to 226% |

4. The proposed levels of refined flour fortification by iron don't ensure acceptable levels of total daily intake (in% RNI/day) of **iron** in females of 10-50 years old in all participating countries:

- Pakistan: 11% to 13%
- Afghanistan: 16% to 18%
- Tajikistan: 19% to 21%
- Kyrgyzstan: 21% to 23%
- Kazakhstan: 21% to 24%
- Uzbekistan: 25% to 28%.

5. The proposed levels of refined flour fortification by iron ensure more acceptable levels of total daily intake (in % RNI/day) of **iron** in other age and gender population groups in participating countries:

- Pakistan: 25% to 35%
- Afghanistan: 35% to 49%
- Tajikistan: 40% to 59%
- Kyrgyzstan: 44% to 63%
- Kazakhstan: 46% to 65%
- Uzbekistan: 54% to 78%.

Annex 1 – Refined wheat flour fortification characteristics and daily intake of micronutrients by population groups in the composition of fortified wheat flour, in Afghanistan

**Afghanistan:** Low diet bioavailability for minerals

| Nutrient | Addition level to flour, mg/kg | Adjusted upper limit, mg/day | Daily intake of micronutrients in the composition of fortified wheat flour | | |
|---|---|---|---|---|---|
| | | | mg/day[a] | % EAR/day | % RNI/day |
| **Children, 1-3 years:** P-50 Food Intake of target group = 162,4 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,219 | 54,8 | 43,9 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,414 | 103,5 | 82,8 |
| Vit. B-3 (Niacin) | 10,0 | 10,0 | 1,381 | 29,9 | 23,0 |
| Vit. B-9 (Folate) | 1,0 | 0,3 | 0,134 | 189,8 | 151,9 |
| Vit. B-12 | 0,004 | N.D. | 0,0005 | 79,75 | 61,35 |
| Iron (NaFeEDTA) | 15,0 | 4,7 | 2,436 | 97,9 | 42,0 |
| Zinc | 30,0 | 7,0 | 4,873 | 70,5 | 58,7 |
| **Children, 4-6 years:** P-50 Food Intake of target group = 206,3 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,279 | 58,0 | 46,4 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,526 | 109,6 | 87,7 |
| Vit. B-3 (Niacin) | 10,0 | 15,0 | 1,754 | 28,5 | 21,9 |
| Vit. B-9 (Folate) | 1,0 | 0,4 | 0,170 | 180,9 | 144,7 |
| Vit. B-12 | 0,004 | N.D. | 0,0005 | 70,15 | 58,45 |
| Iron (NaFeEDTA) | 15,0 | 7,2 | 3,095 | 119,4 | 49,1 |
| Zinc | 30,0 | 12,0 | 6,190 | 77,4 | 64,5 |
| **Children, 7-9 years:** P-50 Food Intake of target group = 259,0g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,350 | 48,6 | 38,9 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,660 | 91,7 | 73,4 |
| Vit. B-3 (Niacin) | 10,0 | 17,0 | 2,202 | 23,9 | 18,3 |
| Vit. B-9 (Folate) | 1,0 | 0,5 | 0,214 | 151,4 | 121,1 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 58,7 | 48,9 |
| Iron (NaFeEDTA) | 15,0 | 10,1 | 3,885 | 106,1 | 43,7 |
| Zinc | 30,0 | 12,0 | 7,770 | 83,3 | 69,4 |
| **Males, 10-18 years:** P-50 Food Intake of target group = 403,9 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,545 | 54,5 | 45,4 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 1,030 | 95,1 | 79,2 |
| Vit. B-3 (Niacin) | 10,0 | 25,0 | 3,433 | 27,9 | 21,5 |
| Vit. B-9 (Folate) | 1,0 | 0,7 | 0,333 | 177,0 | 141,6 |
| Vit. B-12 | 0,004 | N.D. | 0,0015 | 68,65 | 57,2 |
| Iron (NaFeEDTA) | 15,0 | 19,8 | 6,058 | 48,5 | 34,6 |
| Zinc | 30,0 | 28,0 | 12,116 | 85,0 | 70,9 |
| **Males, 19-50 years:** P-50 Food Intake of target group = 439,0 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,593 | 59,3 | 49,4 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 1,119 | 103,3 | 86,1 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 3,732 | 30,3 | 23,3 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,362 | 192,4 | 153,9 |
| Vit. B-12 | 0,004 | N.D. | 0,0015 | 74,65 | 62,2 |
| Iron (NaFeEDTA) | 15,0 | 28,8 | 6,585 | 63,9 | 48,1 |
| Zinc | 30,0 | 45,0 | 13,170 | 112,9 | 94,1 |
| **Males, 51-65 years:** P-50 Food Intake of target group = 430,2 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,581 | 58,1 | 48,4 |

| Nutrient | Addition level to flour, mg/kg | Adjusted upper limit, mg/day | Daily intake of micronutrients in the composition of fortified wheat flour | | |
|---|---|---|---|---|---|
| | | | mg/day[a] | % EAR/day | % RNI/day |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 1,097 | 101,3 | 84,4 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 3,657 | 29,7 | 22,9 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,355 | 188,6 | 150,8 |
| Vit. B-12 | 0,004 | N.D. | 0,0015 | 73,15 | 60,95 |
| Iron (NaFeEDTA) | 15,0 | 27 | 6,453 | 62,6 | 47,1 |
| Zinc | 30,0 | 45,0 | 12,907 | 110,6 | 92,2 |
| **Males, +65 years:** P-50 Food Intake of target group = 360,0 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,486 | 48,6 | 40,5 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,918 | 84,7 | 70,6 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 3,060 | 24,9 | 19,1 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,297 | 157,8 | 126,2 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 61,2 | 51,0 |
| Iron (NaFeEDTA) | 15,0 | 25,2 | 5,400 | 52,4 | 39,4 |
| Zinc | 30,0 | 45,0 | 10,799 | 92,6 | 77,1 |
| **Females, 10-18 years:** P-50 Food Intake of target group = 338,0 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,456 | 49,8 | 41,5 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,862 | 94,8 | 86,2 |
| Vit. B-3 (Niacin) | 10,0 | 25,0 | 2,873 | 23,3 | 18,0 |
| Vit. B-9 (Folate) | 1,0 | 0,7 | 0,279 | 148,2 | 118,5 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 57,45 | 47,9 |
| Iron (NaFeEDTA) | 10,0 | 18 | 5,070 | 29,6 | 15,6 |
| Zinc | 25,0 | 28,0 | 10,141 | 84,5 | 70,4 |
| **Females, 19-50 years:** P-50 Food Intake of target group = 346,8 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,468 | 51,1 | 42,6 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,884 | 96,5 | 80,4 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,948 | 27,4 | 21,1 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,286 | 152,0 | 121,6 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 58,95 | 49,15 |
| Iron (NaFeEDTA) | 15,0 | 23,4 | 5,202 | 39,3 | 17,7 |
| Zinc | 30,0 | 45,0 | 10,404 | 127,4 | 106,2 |
| **Females, 51-65 years:** P-50 Food Intake of target group = 342,4 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,468 | 51,1 | 42,6 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,884 | 96,5 | 80,4 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,948 | 27,4 | 21,1 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,282 | 150,1 | 120,1 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 58,2 | 48,5 |
| Iron (NaFeEDTA) | 15,0 | 25,2 | 5,136 | 100,9 | 45,5 |
| Zinc | 30,0 | 45,0 | 10,273 | 125,8 | 104,8 |
| **Females, +65 years:** P-50 Food Intake of target group = 307,3 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,415 | 45,3 | 37,7 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,784 | 85,5 | 71,2 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,612 | 24,3 | 18,7 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,254 | 134,7 | 107,7 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 52,25 | 43,55 |
| Iron (NaFeEDTA) | 15,0 | 21,6 | 4,610 | 65,3 | 40,8 |
| Zinc | 30,0 | 45,0 | 9,219 | 112,9 | 94,1 |

**Notes:**

[a] - These values are calculated taking in consideration the micronutrient losses during storage and distribution, as well as during cooking.

EAR = Estimated Average Requirement is the daily intake which meets the nutrient requirements of 50% apparently healthy individuals in an age- and sex-specific population.

RNI = Recommended nutrient intake is the daily intake which meets the nutrient requirements of almost all (97.5%) apparently healthy individuals in an age- and sex-specific population.

* N.D. = Not determined

Annex 2 – Refined wheat flour fortification characteristics and daily intake of micronutrients by population groups in the composition of fortified wheat flour, in Kazakhstan

**Kazakhstan:** High diet bioavailability for minerals

| Nutrient | Addition level to flour, mg/kg | Adjusted upper limit, mg/day | Daily intake of micronutrients in the composition of fortified wheat flour | | |
|---|---|---|---|---|---|
| | | | mg/day[a] | % EAR/day | % RNI/day |
| **Children, 1-3 years:** P-50 Food Intake of target group = 95,7 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,129 | 32,3 | 25,8 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,244 | 61,0 | 48,8 |
| Vit. B-3 (Niacin) | 10,0 | 10,0 | 0,814 | 17,6 | 13,6 |
| Vit. B-9 (Folate) | 1,0 | 0,3 | 0,079 | 111,9 | 89,5 |
| Vit. B-12 | 0,004 | ND | 0,0005 | 47,0 | 36,15 |
| Iron (NaFeEDTA) | 15,0 | 4,7 | 1,436 | 129,8 | 55,7 |
| Zinc | 30,0 | 7,0 | 2,872 | 84,0 | 70,0 |
| **Children, 4-6 years:** P-50 Food Intake of target group = 121,6 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,164 | 34,2 | 27,4 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,310 | 64,6 | 51,7 |
| Vit. B-3 (Niacin) | 10,0 | 15,0 | 1,034 | 16,8 | 12,9 |
| Vit. B-9 (Folate) | 1,0 | 0,4 | 0,100 | 106,6 | 85,3 |
| Vit. B-12 | 0,004 | ND | 0,0005 | 41,4 | 34,45 |
| Iron (NaFeEDTA) | 15,0 | 7,2 | 1,824 | 158,3 | 65,1 |
| Zinc | 30,0 | 12,0 | 3,648 | 91,2 | 76,0 |
| **Children, 7-9 years:** P-50 Food Intake of target group = 152,6 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,206 | 28,6 | 22,9 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,389 | 54,1 | 43,2 |
| Vit. B-3 (Niacin) | 10,0 | 17,0 | 1,297 | 14,1 | 10,8 |
| Vit. B-9 (Folate) | 1,0 | 0,5 | 0,126 | 89,2 | 71,4 |
| Vit. B-12 | 0,004 | ND | 0,0005 | 34,6 | 28,85 |
| Iron (NaFeEDTA) | 15,0 | 10,1 | 2,289 | 140,6 | 57,9 |
| Zinc | 30,0 | 12,0 | 4,579 | 98,1 | 81,8 |
| **Males, 10-18 years:** P-50 Food Intake of target group = 238,0 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,321 | 32,1 | 26,8 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,607 | 56,0 | 46,7 |
| Vit. B-3 (Niacin) | 10,0 | 25,0 | 2,023 | 16,4 | 12,6 |
| Vit. B-9 (Folate) | 1,0 | 0,7 | 0,196 | 104,3 | 83,5 |
| Vit. B-12 | 0,004 | ND | 0,001 | 40,5 | 33,7 |
| Iron (NaFeEDTA) | 15,0 | 19,8 | 3,570 | 64,3 | 45,9 |
| Zinc | 30,0 | 28,0 | 7,140 | 99,6 | 83,0 |
| **Males, 19-50 years:** P-50 Food Intake of target group = 258,7 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,349 | 34,9 | 29,1 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,660 | 60,9 | 50,7 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,199 | 17,9 | 13,7 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,213 | 113,4 | 90,7 |
| Vit. B-12 | 0,004 | ND | 0,001 | 44,0 | 36,65 |
| Iron (NaFeEDTA) | 15,0 | 28,8 | 3,881 | 84,8 | 63,7 |
| Zinc | 30,0 | 45,0 | 7,761 | 133,0 | 110,9 |
| **Males, 51-65 years:** P-50 Food Intake of target group = 253,5 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,342 | 34,2 | 28,5 |

| Nutrient | Addition level to flour, mg/kg | Adjusted upper limit, mg/day | Daily intake of micronutrients in the composition of fortified wheat flour | | |
|---|---|---|---|---|---|
| | | | mg/day[a] | % EAR/day | % RNI/day |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,646 | 59,7 | 49,7 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,155 | 17,5 | 13,5 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,209 | 111,1 | 88,9 |
| Vit. B-12 | 0,004 | ND | 0,001 | 43,1 | 35,9 |
| Iron (NaFeEDTA) | 15,0 | 27,0 | 3,803 | 83,1 | 62,5 |
| Zinc | 30,0 | 45,0 | 7,606 | 130,4 | 108,7 |
| **Males, +65 years:** P-50 Food Intake of target group = 212,1 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,286 | 28,6 | 23,9 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,541 | 49,9 | 41,6 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 1,803 | 14,7 | 11,3 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,175 | 93,0 | 74,4 |
| Vit. B-12 | 0,004 | ND | 0,0005 | 36,1 | 30,05 |
| Iron (NaFeEDTA) | 15,0 | 25,2 | 3,182 | 69,5 | 52,3 |
| Zinc | 30,0 | 45,0 | 6,364 | 109,1 | 90,9 |
| **Females, 10-18 years:** P-50 Food Intake of target group = 199,2 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,269 | 29,3 | 24,4 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,508 | 55,9 | 50,8 |
| Vit. B-3 (Niacin) | 10,0 | 25,0 | 1,693 | 13,8 | 10,6 |
| Vit. B-9 (Folate) | 1,0 | 0,7 | 0,164 | 87,3 | 69,8 |
| Vit. B-12 | 0,004 | ND | 0,0005 | 33,9 | 28,2 |
| Iron (NaFeEDTA) | 15,0 | 18,0 | 2,988 | 39,3 | 20,7 |
| Zinc | 30,0 | 28,0 | 5,976 | 99,6 | 83,0 |
| **Females, 19-50 years:** P-50 Food Intake of target group = 204,4 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,276 | 30,1 | 25,1 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,521 | 56,9 | 47,4 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 1,737 | 16,1 | 12,4 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,169 | 89,6 | 71,7 |
| Vit. B-12 | 0,004 | ND | 0,0005 | 34,8 | 28,95 |
| Iron (NaFeEDTA) | 15,0 | 23,4 | 3,066 | 52,1 | 23,5 |
| Zinc | 30,0 | 45,0 | 6,131 | 150,2 | 125,1 |
| **Females, 51-65 years:** P-50 Food Intake of target group = 201,8 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,272 | 29,7 | 24,8 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,515 | 56,1 | 46,8 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 1,715 | 15,9 | 12,3 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,166 | 88,4 | 70,8 |
| Vit. B-12 | 0,004 | ND | 0,0005 | 34,3 | 28,6 |
| Iron (NaFeEDTA) | 15,0 | 25,2 | 3,027 | 133,8 | 60,3 |
| Zinc | 30,0 | 45,0 | 6,054 | 148,3 | 123,5 |
| **Females, +65 years:** P-50 Food Intake of target group = 181,1 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,244 | 26,7 | 22,2 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,462 | 50,4 | 42,0 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 1,539 | 14,3 | 11,0 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,149 | 79,4 | 63,5 |
| Vit. B-12 | 0,004 | ND | 0,0005 | 30,8 | 25,65 |
| Iron (NaFeEDTA) | 15,0 | 21,6 | 2,716 | 86,5 | 54,1 |
| Zinc | 30,0 | 45,0 | 5,433 | 133,0 | 110,9 |

**Notes:**

[a] - These values are calculated taking in consideration the micronutrient losses during storage and distribution, as well as during cooking.

EAR = Estimated Average Requirement is the daily intake which meets the nutrient requirements of 50% apparently healthy individuals in an age- and sex-specific population.

RNI = Recommended nutrient intake is the daily intake which meets the nutrient requirements of almost all (97.5%) apparently healthy individuals in an age- and sex-specific population.

* N.D. = Not determined

Annex 3 – Refined wheat flour fortification characteristics and daily intake of micronutrients by population groups in the composition of fortified wheat flour, in Kyrgyzstan

**Kyrgyzstan:** Moderate diet bioavailability for minerals

| Nutrient | Addition level to flour, mg/kg | Adjusted upper limit, mg/day | Daily intake of micronutrients in the composition of fortified wheat flour | | |
|---|---|---|---|---|---|
| | | | mg/day[a] | % EAR/day | % RNI/day |
| **Children, 1-3 years:** P-50 Food Intake of target group = 139,8 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,189 | 47,2 | 37,8 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,357 | 89,1 | 71,3 |
| Vit. B-3 (Niacin) | 10,0 | 10,0 | 1,188 | 25,8 | 19,8 |
| Vit. B-9 (Folate) | 1,0 | 0,3 | 0,115 | 163,4 | 130,7 |
| Vit. B-12 | 0,004 | N.D. | 0,0005 | 68,7 | 52,8 |
| Iron (NaFeEDTA) | 15,0 | 4,7 | 2,097 | 126,4 | 54,2 |
| Zinc | 30,0 | 7,0 | 4,195 | 122,8 | 102,3 |
| **Children, 4-6 years:** P-50 Food Intake of target group = 177,6 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,240 | 50,0 | 40,0 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,453 | 94,4 | 75,5 |
| Vit. B-3 (Niacin) | 10,0 | 15,0 | 1,510 | 24,5 | 18,9 |
| Vit. B-9 (Folate) | 1,0 | 0,4 | 0,147 | 155,7 | 124,6 |
| Vit. B-12 | 0,004 | N.D. | 0,0005 | 60,4 | 50,3 |
| Iron (NaFeEDTA) | 15,0 | 7,2 | 2,664 | 154,1 | 63,4 |
| Zinc | 30,0 | 12,0 | 5,328 | 133,2 | 111,0 |
| **Children, 7-9 years:** P-50 Food Intake of target group = 223,0 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,301 | 41,8 | 33,4 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,569 | 79,0 | 63,2 |
| Vit. B-3 (Niacin) | 10,0 | 17,0 | 1,895 | 20,5 | 15,8 |
| Vit. B-9 (Folate) | 1,0 | 0,5 | 0,184 | 130,3 | 104,2 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 50,6 | 42,1 |
| Iron (NaFeEDTA) | 15,0 | 10,1 | 3,344 | 137,0 | 56,4 |
| Zinc | 30,0 | 12,0 | 6,689 | 143,3 | 119,4 |
| **Males, 10-18 years:** P-50 Food Intake of target group = 347,7 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,469 | 46,9 | 39,1 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,887 | 81,8 | 68,2 |
| Vit. B-3 (Niacin) | 10,0 | 25,0 | 2,955 | 24,0 | 18,5 |
| Vit. B-9 (Folate) | 1,0 | 0,7 | 0,287 | 152,4 | 121,9 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 59,1 | 49,25 |
| Iron (NaFeEDTA) | 15,0 | 19,8 | 5,215 | 60,8 | 43,5 |
| Zinc | 30,0 | 28,0 | 10,430 | 145,5 | 121,3 |
| **Males, 19-50 years:** P-50 Food Intake of target group = 377,9 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,510 | 51,0 | 42,5 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,964 | 89,0 | 74,1 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 3,212 | 26,1 | 20,1 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,312 | 165,6 | 132,5 |
| Vit. B-12 | 0,004 | N.D. | 0,0015 | 64,3 | 53,55 |
| Iron (NaFeEDTA) | 15,0 | 28,8 | 5,669 | 82,5 | 62,1 |
| Zinc | 30,0 | 45,0 | 11,337 | 194,3 | 162,0 |
| **Males, 51-65 years:** P-50 Food Intake of target group = 370,3 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,500 | 50,0 | 41,7 |

| Nutrient | Addition level to flour, mg/kg | Adjusted upper limit, mg/day | Daily intake of micronutrients in the composition of fortified wheat flour | | |
|---|---|---|---|---|---|
| | | | mg/day[a] | % EAR/day | % RNI/day |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,944 | 87,2 | 72,6 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 3,148 | 25,6 | 19,7 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,306 | 162,3 | 129,9 |
| Vit. B-12 | 0,004 | N.D. | 0,0015 | 63,0 | 52,45 |
| Iron (NaFeEDTA) | 15,0 | 27 | 5,555 | 80,9 | 60,8 |
| Zinc | 30,0 | 45,0 | 11,110 | 190,5 | 158,7 |
| **Males, +65 years:** P-50 Food Intake of target group = 309,9 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,418 | 41,8 | 34,9 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,790 | 72,9 | 60,8 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,634 | 21,4 | 16,5 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,256 | 135,8 | 108,7 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 52,7 | 43,9 |
| Iron (NaFeEDTA) | 15,0 | 25,2 | 4,648 | 67,7 | 50,9 |
| Zinc | 30,0 | 45,0 | 9,296 | 159,4 | 132,8 |
| **Females, 10-18 years:** P-50 Food Intake of target group = 291,0 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,393 | 42,9 | 35,7 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,742 | 81,6 | 74,2 |
| Vit. B-3 (Niacin) | 10,0 | 25,0 | 2,473 | 20,1 | 15,5 |
| Vit. B-9 (Folate) | 1,0 | 0,7 | 0,240 | 127,5 | 102,0 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 49,5 | 41,2 |
| Iron (NaFeEDTA) | 15,0 | 18 | 4,365 | 38,9 | 20,5 |
| Zinc | 30,0 | 28,0 | 8,729 | 145,5 | 121,2 |
| **Females, 19-50 years:** P-50 Food Intake of target group = 298,5 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,403 | 44,0 | 36,6 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,761 | 83,0 | 69,2 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,538 | 23,6 | 18,1 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,246 | 130,8 | 104,7 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 50,8 | 42,3 |
| Iron (NaFeEDTA) | 15,0 | 23,4 | 4,478 | 50,7 | 22,8 |
| Zinc | 30,0 | 45,0 | 8,956 | 219,3 | 182,8 |
| **Females, 51-65 years:** P-50 Food Intake of target group = 294,8 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,398 | 43,4 | 36,2 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,752 | 82,0 | 68,3 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,505 | 23,3 | 17,9 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,243 | 129,2 | 103,4 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 50,1 | 41,75 |
| Iron (NaFeEDTA) | 15,0 | 25,2 | 4,421 | 130,3 | 58,7 |
| Zinc | 30,0 | 45,0 | 8,843 | 216,6 | 180,5 |
| **Females, +65 years:** P-50 Food Intake of target group = 264,5 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,357 | 39,0 | 32,5 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,675 | 73,6 | 61,3 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,249 | 20,9 | 16,1 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,218 | 115,9 | 92,8 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 45,0 | 37,5 |
| Iron (NaFeEDTA) | 15,0 | 21,6 | 3,968 | 84,3 | 52,7 |
| Zinc | 30,0 | 45,0 | 7,936 | 194,3 | 162,0 |

**Notes:**

[a] - These values are calculated taking in consideration the micronutrient losses during storage and distribution, as well as during cooking.

EAR = Estimated Average Requirement is the daily intake which meets the nutrient requirements of 50% apparently healthy individuals in an age- and sex-specific population.

RNI = Recommended nutrient intake is the daily intake which meets the nutrient requirements of almost all (97.5%) apparently healthy individuals in an age- and sex-specific population.

* N.D. = Not determined

Annex 4 – Refined wheat flour fortification characteristics and daily intake of micronutrients by population groups in the composition of fortified wheat flour, in Pakistan

**Pakistan:** Low diet bioavailability for minerals

| Nutrient | Addition level to flour, mg/kg | Adjusted upper limit, mg/day | Daily intake of micronutrients in the composition of fortified wheat flour | | |
|---|---|---|---|---|---|
| | | | mg/day[a] | % EAR/day | % RNI/day |
| **Children, 1-3 years:** P-50 Food Intake of target group = 115,2 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,155 | 38,9 | 31,1 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,294 | 73,4 | 58,7 |
| Vit. B-3 (Niacin) | 10,0 | 10,0 | 0,979 | 21,2 | 16,3 |
| Vit. B-9 (Folate) | 1,0 | 0,3 | 0,095 | 134,6 | 107,7 |
| Vit. B-12 | 0,004 | N.D. | 0,0005 | 56,6 | 43,5 |
| Iron (NaFeEDTA) | 15,0 | 4,7 | 1,728 | 69,4 | 29,8 |
| Zinc | 30,0 | 7,0 | 3,455 | 50,0 | 41,6 |
| **Children, 4-6 years:** P-50 Food Intake of target group = 146,3 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,198 | 41,1 | 32,9 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,373 | 77,7 | 62,2 |
| Vit. B-3 (Niacin) | 10,0 | 15,0 | 1,244 | 20,2 | 15,5 |
| Vit. B-9 (Folate) | 1,0 | 0,4 | 0,121 | 128,3 | 102,6 |
| Vit. B-12 | 0,004 | N.D. | 0,0005 | 49,8 | 41,45 |
| Iron (NaFeEDTA) | 15,0 | 7,2 | 2,195 | 84,7 | 34,8 |
| Zinc | 30,0 | 12,0 | 4,389 | 54,9 | 45,7 |
| **Children, 7-9 years:** P-50 Food Intake of target group = 183,7 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,248 | 34,4 | 27,6 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,468 | 65,0 | 52,0 |
| Vit. B-3 (Niacin) | 10,0 | 17,0 | 1,561 | 16,9 | 13,0 |
| Vit. B-9 (Folate) | 1,0 | 0,5 | 0,152 | 107,3 | 85,9 |
| Vit. B-12 | 0,004 | N.D. | 0,0005 | 41,7 | 34,7 |
| Iron (NaFeEDTA) | 15,0 | 10,1 | 2,755 | 75,2 | 31,0 |
| Zinc | 30,0 | 12,0 | 5,510 | 59,0 | 49,2 |
| **Males, 10-18 years:** P-50 Food Intake of target group = 286,4 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,387 | 38,7 | 32,2 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,730 | 67,4 | 56,2 |
| Vit. B-3 (Niacin) | 10,0 | 25,0 | 2,434 | 19,8 | 15,2 |
| Vit. B-9 (Folate) | 1,0 | 0,7 | 0,236 | 125,5 | 100,4 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 48,7 | 40,55 |
| Iron (NaFeEDTA) | 15,0 | 19,8 | 4,296 | 34,4 | 24,5 |
| Zinc | 30,0 | 28,0 | 8,592 | 60,3 | 50,2 |
| **Males, 19-50 years:** P-50 Food Intake of target group = 311,3 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,420 | 42,0 | 35,0 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,794 | 73,3 | 61,1 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,646 | 21,5 | 16,5 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,257 | 136,4 | 109,1 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 52,9 | 44,1 |
| Iron (NaFeEDTA) | 15,0 | 28,8 | 4,670 | 45,3 | 34,1 |
| Zinc | 30,0 | 45,0 | 9,339 | 80,0 | 66,7 |
| **Males, 51-65 years:** P-50 Food Intake of target group = 305,1 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,412 | 41,2 | 34,3 |

| Nutrient | Addition level to flour, mg/kg | Adjusted upper limit, mg/day | Daily intake of micronutrients in the composition of fortified wheat flour | | |
|---|---|---|---|---|---|
| | | | mg/day[a] | % EAR/day | % RNI/day |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,778 | 71,8 | 59,8 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,593 | 21,1 | 16,2 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,252 | 133,7 | 107,0 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 51,9 | 43,2 |
| Iron (NaFeEDTA) | 15,0 | 27 | 4,576 | 44,4 | 33,4 |
| Zinc | 30,0 | 45,0 | 9,152 | 78,4 | 65,4 |
| **Males, +65 years:** P-50 Food Intake of target group = 255,3 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,345 | 34,5 | 28,7 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,651 | 60,1 | 50,1 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,170 | 17,6 | 13,6 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,211 | 111,9 | 89,5 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 43,4 | 36,15 |
| Iron (NaFeEDTA) | 15,0 | 25,2 | 3,829 | 37,2 | 27,9 |
| Zinc | 30,0 | 45,0 | 7,658 | 65,6 | 54,7 |
| **Females, 10-18 years:** P-50 Food Intake of target group = 239,7 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,324 | 35,3 | 29,4 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,611 | 67,2 | 61,1 |
| Vit. B-3 (Niacin) | 10,0 | 25,0 | 2,037 | 16,6 | 12,7 |
| Vit. B-9 (Folate) | 1,0 | 0,7 | 0,198 | 105,1 | 84,0 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 40,8 | 33,95 |
| Iron (NaFeEDTA) | 15,0 | 18 | 3,596 | 21,0 | 11,1 |
| Zinc | 30,0 | 28,0 | 7,191 | 59,9 | 49,9 |
| **Females, 19-50 years:** P-50 Food Intake of target group = 245,9 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,332 | 36,2 | 30,2 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,627 | 68,4 | 57,0 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,090 | 19,4 | 14,9 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,203 | 107,8 | 86,2 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 41,8 | 34,85 |
| Iron (NaFeEDTA) | 15,0 | 23,4 | 3,689 | 27,9 | 12,5 |
| Zinc | 30,0 | 45,0 | 7,378 | 90,3 | 75,3 |
| **Females, 51-65 years:** P-50 Food Intake of target group = 242,8 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,328 | 35,8 | 29,8 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,619 | 67,5 | 56,3 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,064 | 19,2 | 14,7 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,200 | 106,4 | 85,1 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 41,3 | 34,4 |
| Iron (NaFeEDTA) | 15,0 | 25,2 | 3,642 | 71,6 | 32,2 |
| Zinc | 30,0 | 45,0 | 7,284 | 89,2 | 74,3 |
| **Females, +65 years:** P-50 Food Intake of target group = 217,9 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,294 | 32,1 | 26,7 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,556 | 60,6 | 50,5 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 1,852 | 17,2 | 13,2 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,180 | 95,5 | 76,4 |
| Vit. B-12 | 0,004 | N.D. | 0,0005 | 37,1 | 30,85 |
| Iron (NaFeEDTA) | 15,0 | 21,6 | 3,269 | 46,3 | 28,9 |
| Zinc | 30,0 | 45,0 | 6,537 | 80,0 | 66,7 |

**Notes:**

[a] - These values are calculated taking in consideration the micronutrient losses during storage and distribution, as well as during cooking.

EAR = Estimated Average Requirement is the daily intake which meets the nutrient requirements of 50 apparently healthy individuals in an age- and sex-specific population.

RNI = Recommended nutrient intake is the daily intake which meets the nutrient requirements of almost all (97.5) apparently healthy individuals in an age- and sex-specific population.

* N.D. = Not determined

Annex 5 – Refined wheat flour fortification characteristics and daily intake of micronutrients by population groups in the composition of fortified wheat flour, in Tajikistan

**Tajikistan:** Moderate diet bioavailability for minerals

| Nutrient | Addition level to flour, mg/kg | Adjusted upper limit, mg/day | Daily intake of micronutrients in the composition of fortified wheat flour | | |
|---|---|---|---|---|---|
| | | | mg/day[a] | EAR/day | RNI/day |
| **Children, 1-3 years:** P-50 Food Intake of target group = 129,6 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,175 | 43,7 | 35,0 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,331 | 82,6 | 66,1 |
| Vit. B-3 (Niacin) | 10,0 | 10,0 | 1,102 | 23,9 | 18,4 |
| Vit. B-9 (Folate) | 1,0 | 0,3 | 0,107 | 151,5 | 121,2 |
| Vit. B-12 | 0,004 | N.D. | 0,0005 | 63,7 | 48,95 |
| Iron (NaFeEDTA) | 15,0 | 4,7 | 1,944 | 117,2 | 50,3 |
| Zinc | 30,0 | 7,0 | 3,888 | 113,8 | 94,8 |
| **Children, 4-6 years:** P-50 Food Intake of target group = 164,6 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,222 | 46,3 | 37,0 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,420 | 87,5 | 70,0 |
| Vit. B-3 (Niacin) | 10,0 | 15,0 | 1,399 | 22,7 | 17,5 |
| Vit. B-9 (Folate) | 1,0 | 0,4 | 0,136 | 144,3 | 115,5 |
| Vit. B-12 | 0,004 | N.D. | 0,0005 | 56,0 | 46,65 |
| Iron (NaFeEDTA) | 15,0 | 7,2 | 2,470 | 142,9 | 58,8 |
| Zinc | 30,0 | 12,0 | 4,939 | 123,5 | 102,9 |
| **Children, 7-9 years:** P-50 Food Intake of target group = 206,7 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,279 | 38,8 | 31,0 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,527 | 73,2 | 58,6 |
| Vit. B-3 (Niacin) | 10,0 | 17,0 | 1,757 | 19,0 | 14,6 |
| Vit. B-9 (Folate) | 1,0 | 0,5 | 0,171 | 120,8 | 96,6 |
| Vit. B-12 | 0,004 | N.D. | 0,0005 | 46,9 | 39,05 |
| Iron (NaFeEDTA) | 15,0 | 10,1 | 3,100 | 127,0 | 52,2 |
| Zinc | 30,0 | 12,0 | 6,200 | 132,9 | 110,7 |
| **Males, 10-18 years:** P-50 Food Intake of target group = 322,3 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,435 | 43,5 | 36,3 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,822 | 75,9 | 63,2 |
| Vit. B-3 (Niacin) | 10,0 | 25,0 | 2,739 | 22,3 | 17,1 |
| Vit. B-9 (Folate) | 1,0 | 0,7 | 0,266 | 141,2 | 113,0 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 54,8 | 45,65 |
| Iron (NaFeEDTA) | 15,0 | 19,8 | 4,834 | 56,4 | 40,3 |
| Zinc | 30,0 | 28,0 | 9,668 | 134,9 | 112,4 |
| **Males, 19-50 years:** P-50 Food Intake of target group = 350,3 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,473 | 47,3 | 39,4 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,893 | 82,5 | 68,7 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,978 | 24,2 | 18,6 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,289 | 153,5 | 122,8 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 59,6 | 49,65 |
| Iron (NaFeEDTA) | 15,0 | 28,8 | 5,255 | 76,5 | 57,5 |
| Zinc | 30,0 | 45,0 | 10,509 | 180,2 | 150,1 |
| **Males, 51-65 years:** P-50 Food Intake of target group = 343,3 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,463 | 46,3 | 38,6 |

| Nutrient | Addition level to flour, mg/kg | Adjusted upper limit, mg/day | Daily intake of micronutrients in the composition of fortified wheat flour | | |
|---|---|---|---|---|---|
| | | | mg/day[a] | EAR/day | RNI/day |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,875 | 80,8 | 67,3 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,918 | 23,7 | 18,2 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,283 | 150,5 | 120,4 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 58,4 | 48,65 |
| Iron (NaFeEDTA) | 15,0 | 27 | 5,149 | 75,0 | 56,4 |
| Zinc | 30,0 | 45,0 | 10,299 | 176,6 | 147,1 |
| **Males, +65 years:** P-50 Food Intake of target group = 287,2 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,388 | 38,8 | 32,3 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,732 | 67,6 | 56,3 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,442 | 19,8 | 15,3 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,237 | 125,9 | 100,7 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 48,9 | 40,7 |
| Iron (NaFeEDTA) | 15,0 | 25,2 | 4,309 | 62,7 | 47,2 |
| Zinc | 30,0 | 45,0 | 8,617 | 147,7 | 123,1 |
| **Females, 10-18 years:** P-50 Food Intake of target group = 269,7 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,364 | 39,7 | 33,1 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,688 | 75,7 | 68,8 |
| Vit. B-3 (Niacin) | 10,0 | 25,0 | 2,293 | 18,6 | 14,3 |
| Vit. B-9 (Folate) | 1,0 | 0,7 | 0,223 | 118,2 | 94,6 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 45,9 | 38,2 |
| Iron (NaFeEDTA) | 15,0 | 18 | 4,046 | 36,0 | 19,0 |
| Zinc | 30,0 | 28,0 | 8,092 | 134,9 | 112,4 |
| **Females, 19-50 years:** P-50 Food Intake of target group = 276,7 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,374 | 40,8 | 34,0 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,706 | 77,0 | 64,2 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,352 | 21,8 | 16,8 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,228 | 121,3 | 97,0 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 47,1 | 39,2 |
| Iron (NaFeEDTA) | 15,0 | 23,4 | 4,151 | 47,0 | 21,2 |
| Zinc | 30,0 | 45,0 | 8,302 | 203,3 | 169,4 |
| **Females, 51-65 years:** P-50 Food Intake of target group = 273,2 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,369 | 40,2 | 33,5 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,697 | 76,0 | 63,3 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,322 | 21,6 | 16,6 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,225 | 119,8 | 95,8 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 46,5 | 38,7 |
| Iron (NaFeEDTA) | 15,0 | 25,2 | 4,099 | 120,8 | 54,4 |
| Zinc | 30,0 | 45,0 | 8,197 | 200,7 | 167,3 |
| **Females, +65 years:** P-50 Food Intake of target group = 245,2 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,331 | 36,1 | 30,1 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,625 | 68,2 | 56,8 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,084 | 19,4 | 14,9 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,202 | 107,5 | 86,0 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 41,7 | 34,75 |
| Iron (NaFeEDTA) | 15,0 | 21,6 | 3,678 | 78,1 | 48,8 |
| Zinc | 30,0 | 45,0 | 7,356 | 180,2 | 150,1 |

**Notes:**

[a] - These values are calculated taking in consideration the micronutrient losses during storage and distribution, as well as during cooking.

EAR = Estimated Average Requirement is the daily intake which meets the nutrient requirements of 50 apparently healthy individuals in an age- and sex-specific population.

RNI = Recommended nutrient intake is the daily intake which meets the nutrient requirements of almost all (97.5) apparently healthy individuals in an age- and sex-specific population.

* N.D. = Not determined

Annex 6 – Refined wheat flour fortification characteristics and daily intake of micronutrients by population groups in the composition of fortified wheat flour, in Uzbekistan

**Uzbekistan:** Moderate diet bioavailability for minerals

| Nutrient | Addition level to flour, mg/kg | Adjusted upper limit, mg/day | Daily intake of micronutrients in the composition of fortified wheat flour | | |
|---|---|---|---|---|---|
| | | | mg/day[a] | EAR/day | RNI/day |
| **Children, 1-3 years:** P-50 Food Intake of target group = 172,9 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,233 | 58,4 | 46,7 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,441 | 110,2 | 88,2 |
| Vit. B-3 (Niacin) | 10,0 | 10,0 | 1,470 | 31,8 | 24,5 |
| Vit. B-9 (Folate) | 1,0 | 0,3 | 0,143 | 202,1 | 161,7 |
| Vit. B-12 | 0,004 | N.D. | 0,0005 | 84,9 | 65,3 |
| Iron (NaFeEDTA) | 15,0 | 4,7 | 2,594 | 156,3 | 67,1 |
| Zinc | 30,0 | 7,0 | 5,187 | 151,8 | 126,5 |
| **Children, 4-6 years:** P-50 Food Intake of target group = 219,6 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,297 | 61,8 | 49,4 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,560 | 116,7 | 93,3 |
| Vit. B-3 (Niacin) | 10,0 | 15,0 | 1,867 | 30,3 | 23,3 |
| Vit. B-9 (Folate) | 1,0 | 0,4 | 0,181 | 192,5 | 154,0 |
| Vit. B-12 | 0,004 | N.D. | 0,0005 | 74,7 | 62,25 |
| Iron (NaFeEDTA) | 15,0 | 7,2 | 3,294 | 190,6 | 78,4 |
| Zinc | 30,0 | 12,0 | 6,589 | 164,7 | 137,3 |
| **Children, 7-9 years:** P-50 Food Intake of target group = 275,7 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,372 | 51,7 | 41,4 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,703 | 97,6 | 78,1 |
| Vit. B-3 (Niacin) | 10,0 | 17,0 | 2,344 | 25,4 | 19,5 |
| Vit. B-9 (Folate) | 1,0 | 0,5 | 0,227 | 161,1 | 128,9 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 62,5 | 52,1 |
| Iron (NaFeEDTA) | 15,0 | 10,1 | 4,136 | 169,4 | 69,7 |
| Zinc | 30,0 | 12,0 | 8,271 | 177,2 | 147,7 |
| **Males, 10-18 years:** P-50 Food Intake of target group = 429,9 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,580 | 58,0 | 48,4 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 1,096 | 101,2 | 84,3 |
| Vit. B-3 (Niacin) | 10,0 | 25,0 | 3,654 | 29,7 | 22,8 |
| Vit. B-9 (Folate) | 1,0 | 0,7 | 0,355 | 188,4 | 150,7 |
| Vit. B-12 | 0,004 | N.D. | 0,0015 | 73,1 | 60,9 |
| Iron (NaFeEDTA) | 15,0 | 19,8 | 6,449 | 75,2 | 53,7 |
| Zinc | 30,0 | 28,0 | 12,897 | 180,0 | 150,0 |
| **Males, 19-50 years:** P-50 Food Intake of target group = 467,3 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,631 | 63,1 | 52,6 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 1,192 | 110,0 | 91,7 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 3,972 | 32,3 | 24,8 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,386 | 204,8 | 163,8 |
| Vit. B-12 | 0,004 | N.D. | 0,0015 | 79,5 | 66,2 |
| Iron (NaFeEDTA) | 15,0 | 28,8 | 7,010 | 102,1 | 76,7 |
| Zinc | 30,0 | 45,0 | 14,019 | 240,3 | 200,3 |
| **Males, 51-65 years:** P-50 Food Intake of target group = 458,0 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,618 | 61,8 | 51,5 |

| Nutrient | Addition level to flour, mg/kg | Adjusted upper limit, mg/day | Daily intake of micronutrients in the composition of fortified wheat flour | | |
|---|---|---|---|---|---|
| | | | mg/day[a] | EAR/day | RNI/day |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 1,168 | 107,8 | 89,8 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 3,893 | 31,6 | 24,3 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,378 | 200,7 | 160,6 |
| Vit. B-12 | 0,004 | N.D. | 0,0015 | 77,9 | 64,9 |
| Iron (NaFeEDTA) | 15,0 | 27 | 6,869 | 100,0 | 75,2 |
| Zinc | 30,0 | 45,0 | 13,739 | 235,5 | 196,3 |
| **Males, +65 years:** P-50 Food Intake of target group = 383,2 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,517 | 51,7 | 43,1 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,977 | 90,2 | 75,2 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 3,257 | 26,5 | 20,4 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,316 | 167,9 | 134,4 |
| Vit. B-12 | 0,004 | N.D. | 0,0015 | 65,2 | 54,3 |
| Iron (NaFeEDTA) | 15,0 | 25,2 | 5,748 | 83,7 | 62,9 |
| Zinc | 30,0 | 45,0 | 11,496 | 197,1 | 164,2 |
| **Females, 10-18 years:** P-50 Food Intake of target group = 359,8 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,486 | 53,0 | 44,2 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,918 | 100,9 | 91,8 |
| Vit. B-3 (Niacin) | 10,0 | 25,0 | 3,058 | 24,9 | 19,1 |
| Vit. B-9 (Folate) | 1,0 | 0,7 | 0,297 | 157,7 | 126,2 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 61,2 | 50,95 |
| Iron (NaFeEDTA) | 15,0 | 18 | 5,397 | 48,1 | 25,3 |
| Zinc | 30,0 | 28,0 | 10,795 | 179,9 | 149,9 |
| **Females, 19-50 years:** P-50 Food Intake of target group = 369,2 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,498 | 54,4 | 45,3 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,941 | 102,7 | 85,6 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 3,138 | 29,1 | 22,4 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,305 | 161,8 | 129,4 |
| Vit. B-12 | 0,004 | N.D. | 0,0015 | 62,8 | 52,3 |
| Iron (NaFeEDTA) | 15,0 | 23,4 | 5,538 | 62,7 | 28,3 |
| Zinc | 30,0 | 45,0 | 11,075 | 271,2 | 226,0 |
| **Females, 51-65 years:** P-50 Food Intake of target group = 364,5 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,492 | 53,7 | 44,7 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,929 | 101,4 | 84,5 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 3,098 | 28,8 | 22,1 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,301 | 159,8 | 127,8 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 62,0 | 51,65 |
| Iron (NaFeEDTA) | 15,0 | 25,2 | 5,467 | 161,1 | 72,6 |
| Zinc | 30,0 | 45,0 | 10,935 | 267,8 | 223,2 |
| **Females, +65 years:** P-50 Food Intake of target group = 327,1 g/day | | | | | |
| Vit. B-1 (Thiamin) | 2,0 | ND | 0,442 | 48,2 | 40,1 |
| Vit. B-2 (Riboflavin) | 3,0 | ND | 0,834 | 91,0 | 75,8 |
| Vit. B-3 (Niacin) | 10,0 | 35,0 | 2,780 | 25,8 | 19,9 |
| Vit. B-9 (Folate) | 1,0 | 1,0 | 0,270 | 143,4 | 114,7 |
| Vit. B-12 | 0,004 | N.D. | 0,001 | 55,6 | 46,35 |
| Iron (NaFeEDTA) | 15,0 | 21,6 | 4,907 | 104,2 | 65,1 |
| Zinc | 30,0 | 45,0 | 9,813 | 240,3 | 200,3 |

**Notes:**

[a] - These values are calculated taking in consideration the micronutrient losses during storage and distribution, as well as during cooking.

EAR = Estimated Average Requirement is the daily intake which meets the nutrient requirements of 50 apparently healthy individuals in an age- and sex-specific population.

RNI = Recommended nutrient intake is the daily intake which meets the nutrient requirements of almost all (97.5) apparently healthy individuals in an age- and sex-specific population.

* N.D. = Not determined

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