REPORT

FORTIFICATION ASSESSMENT COVERAGE TOOLKIT (FACT) SURVEY IN KAZAKHSTAN, 2016

FEBRUARY 2018

DISCLAIMER

This report is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of GAIN, under the terms of Grant No. GHA-G-00-06-00002, and do not necessarily reflect the views of USAID or the United States Government.

For additional information, please contact:

Valerie Friesen
Technical Specialist, Knowledge Leadership
Global Alliance for Improved Nutrition
Rue de Varembé 7
1201 Geneva, Switzerland
Tel: +41 22 749 1850
Email: vfriesen@gainhealth.org

Shamil Tazhibayev
Vice President
Kazakh Academy of Nutrition
Klochkov Street, 66, Almaty
050008, Republic of Kazakhstan
Tel: +7 777 230 2639
Email: stazhibayev@kan-kaz.org

ACKNOWLEDGEMENTS

The survey reported here was jointly led by the Global Alliance for Improved Nutrition (GAIN) and the Kazakh Academy of Nutrition (KAN). The authors would like to thank the Ministry of Health and Social Development of the Republic of Kazakhstan, Akimats and Health Departments in Oblast, Astana and Almaty Cities, and Rayons for supporting the research; Dr. Ferusa Ospanova for conducting the quantitative analyses of iodine in salt samples, Dr. Aigul Sharipbayeva for conducting the quantitative analyses of iron in flour samples, and Aidana Malikova, Kanat Kabdulov, Serik Dzhumagaliyev, Nazira Muratbekova, Marzhan Adilet, Leila Musrepova, Bakhytgul Kylybayeva, Guldana Dauletbakova and Balzhan Razueva for data collection in the field and data entry.

PROJECT IMPLEMENTATION TEAM

Global Alliance for Improved Nutrition, Geneva, Switzerland:

- Valerie Friesen, Technical Specialist

Kazakhstan Academy of Nutrition, Almaty, Kazakhstan:

- Turegeldy Sharmanov, Team Leader
- Shamil Tazhibayev, Executive in Charge
- Baurzhan Dzhusipov, Statistical Analyst
- Oksana Dolmatova, Field Supervisor
- Gaukhar Datkhabayeva, Field Supervisor
- Altyn Sarsembayeva, Field Supervisor

RECOMMENDED CITATION

Global Alliance for Improved Nutrition and Kazakh Academy of Nutrition. 2018. Fortification Assessment Coverage Toolkit (FACT) Survey in Kazakhstan, 2016. Global Alliance for Improved Nutrition: Geneva, Switzerland.

Contents

List of Tables

List of Figures

Acronyms

AME	Adult male equivalent
EAR	Estimated average requirement
FACT	Fortification Assessment Coverage Toolkit
GAIN	Global Alliance for Improved Nutrition
KAN	Kazakh Academy of Nutrition
MPI	Multidimensional poverty index
MT	Metric tons
ppm	Parts per million
PPS	Probability proportional to size
PSU	Primary sampling unit
RNI	Recommended nutrient intake
SPSS	Statistical Package for the Social Sciences
WHO	World Health Organization
WRA	Women of reproductive age

1. Summary

Micronutrient deficiency is widespread in Kazakhstan among women and children. Large-scale food fortification is a cost-effective public health strategy to deliver micronutrients through commonly consumed foods. In Kazakhstan, mandatory fortification of salt with iodine was implemented in 2003 and refined wheat flour with iron, zinc, thiamin, riboflavin, niacin and folic acid in 2004. A cross-sectional survey was conducted among households with at least one child less than five years of age to update coverage figures of foods fortified according to the national standards and estimate the potential contribution of fortified foods to the micronutrient intake among children under five and women of reproductive age. The survey included a total of 2004 households (946 rural and 1058 urban) and was nationally representative and representative of both urban and rural areas. The target population consisted of children (less than five years) and women of reproductive age (15 to 49 years). Information on household demographics and food consumption patterns was collected along with samples of refined wheat flour and bread made from refined wheat. Food samples were analyzed to determine the presence of added fortificant, and, if positive, were analyzed to determine total nutrient levels.

Laboratory analysis of food samples revealed that, for salt, all 16 brands identified were fortified with iodine to some extent, while only six brands were fortified according to the national standard (i.e. 25-55 ppm) and one brand was fortified in excess of the upper limit of the standard. For wheat flour, 169 brands were identified, of which 99 did not contain any added iron. Among the 70 brands that were fortified, all but one brand contained less than the minimum the level of added iron required according to the national standard (i.e. 45-65 ppm).

Four measures of coverage were assessed and are expressed as the proportion of sampled households covered: 1) consumption of a food (i.e. households report preparing the food at home); 2) consumption of a fortifiable food (i.e. consumption of a food vehicle that was not made at home and is assumed to be industrially processed); 3) consumption of a fortified food (i.e. consumption of a food vehicle that is confirmed to be fortified at any level), and 4) consumption of a food vehicle that is fortified according to the national standard.

Consumption of salt and wheat flour, generally and in the fortifiable form, is universal in Kazakhstan (>99% of households). Nationally, iodized salt was consumed by 88% of households. Coverage of iodized salt was lower among rural households compared to urban households (85% vs. 91%). Fortified wheat flour was consumed by 41% of households nationally (up from 27% in 2011). Coverage of fortified wheat flour was lower among rural households compared to urban households (33% vs. 47%). Nearly all households consumed industrially produced bread made from wheat flour (>99%) but only 55% consumed bread made from fortifiable wheat flour, i.e. white/premium or first grade flours (alternative sources included brown, bran or rye bread which are not part of the mandatory fortification program) and only 3% consumed bread made from fortified wheat flour (white/premium or first grade).

The nutrient contribution coming from consumption of fortified foods was expressed for the target populations as a percentage of the estimated average requirement (EAR) and

recommended nutrient intake (RNI) for iodine from salt, and as a percentage of the RNI for added iron from wheat flour.

The contribution of iodine from fortified salt alone to dietary requirements was high across all target populations, exceeding both EAR and RNI requirements. Iodized salt was estimated to contribute on average 149.0% of the EAR for iodine among children 12-23 months, 190.4% among children 24-59 months, and 267.9% among women of reproductive age, nationally. In terms of RNI, these figures were 74% of the RNI for iodine among children 6-11 months, 108% among children 12-23 months, 138% among children 24-59 months, and 170% among women of reproductive age, nationally. Here, it is important to point out that breast milk is an excellent source of iodine, and therefore breastfed children are also receiving the benefit of the iodized salt program. The contribution of added iron from fortified wheat flour alone to the dietary requirements was lower. When expressed as a percentage of RNI, fortified wheat flour was estimated to provide 17%, 25%, and 9% among children 12-23 months, children 24-59 months, and women or reproductive age, respectively, of the RNI for iron. Iron contribution from fortified wheat flour was higher among children 24-59 months and WRA from rural households compared to urban households (30% vs. 22%, and 11% vs. 8%, respectively, of the iron RNI) due to higher intakes.

In summary, in Kazakhstan there is high coverage of fortifiable salt and wheat flour in all areas indicating high potential for fortification of salt and wheat flour to increase nutrient intakes across the entire population. For salt, this potential is being met as the population is receiving sufficient iodine to fulfill the nutrient requirements with all producers fortifying to some extent and a high contribution to iodine requirements in target populations. For wheat flour, the findings demonstrate that recent progress has been made, but improvements are needed for the program to reach its full potential. Compliance with the fortification standard for wheat flour remains a concern, as well as the use of non-fortified wheat flour in the production of industrially-manufactured bread.

2. Background

Micronutrient deficiencies are widespread in Kazakhstan and cause great damage to the health of the population. According to the results of the most recent national survey in 2011, iron deficiency is the most prevalent micronutrient deficiency affecting 38% of children under five and 44% of women of reproductive age (WRA), while anemia affects 35% of children under five and 39% of WRA (Kazakh Academy of Nutrition 2011). However, iodine intakes are sufficient as the median urinary iodine concentration of both children under five and WRA is higher than 100 µg/L.

Large-scale food fortification is a sustainable, scalable and highly-cost effective strategy for improving dietary health in countries or regions where deficiencies exist (World Health Organization and Food and Agriculture Organization 2006). Benefits include significant reductions in iron-deficiency anemia and neural tube defects, such as spina bifida, and can be delivered for less than a dollar per person per year. Around the world, about 2 billion people suffer from micronutrient malnutrition, not only affecting population heath, but also economic productivity, costing some countries as much 2.5% of gross domestic product according to the World Bank.

In an effort to reduce and prevent micronutrient deficiencies, the government of Kazakhstan implemented a mandatory fortification program. In 2003, mandatory legislation was put in place for the fortification of salt with iodine. Salt iodization had occurred previously in Kazakhstan during Soviet times but ceased after the collapse of the Soviet Union. In 2004, mandatory legislation was put in place for the fortification of wheat flour with iron, zinc, thiamin, riboflavin, niacin, and folic acid.

Kazakhstan is a major wheat flour producer with a production capacity of 9,550,256 MT of flour per year though only 40% of the capacity is currently used. In 2013, of the 3,019,190 MT of wheat flour produced and consumed in the country, only 28% of it was fortified. Kazakhstan also exports wheat flour to other countries in the Central Asian Region and to Afghanistan but it is unknown how much of the exported flour is fortified. Recent data on household coverage of these fortified foods vehicles is available. In 2007, Kazakhstan achieved universal salt iodization status (Sharmanov, et al. 2008). A 2011 national survey indicated that household coverage of iodized salt has remained high (91%), while household coverage of fortified wheat flour was relatively low (27%) (Kazakh Academy of Nutrition 2011). However, there remains a lack of information on the adequacy of fortification levels at household level and the contribution of fortified salt and wheat flour to individual nutrient intakes, particularly among at-risk populations.

A cross-sectional survey was conducted by the Global Alliance for Improved Nutrition (GAIN) and the Kazakh Academy of Nutrition (KAN) among households with at least one child less than five years of age using the Fortification Assessment Coverage Toolkit (FACT) developed by GAIN. The purpose of the survey was to update coverage figures of foods fortified according to the national standard and to estimate the potential contribution of fortified foods to the micronutrient intake in the population.

3. Objectives

The main objectives of the survey were to determine the household coverage and contribution of fortified foods to the micronutrient intake of children (less than five years) and women of reproductive age (15 to 49 years) in Kazakhstan.

Specific objectives of the survey were to:

1. To assess the coverage of fortified salt, wheat flour, and wheat flour bread among households;

2. To measure levels of select nutrients in samples of wheat flour (iron) and salt (iodine) collected at households to assess the level of fortification compared to national fortification standards;

3. To estimate the consumption of fortified salt and wheat flour among children (less than five years) and women of reproductive age (15-49 years); and

4. To estimate the contribution of fortified salt and wheat flour to the intake of iodine and iron, respectively, in the diets of children (less than five years) and women of reproductive age (15-49 years).

4. Methodology

4.1 SURVEY DESIGN AND TARGET POPULATION

A national, cross-sectional, three-stage cluster survey with urban and rural stratification was conducted in Kazakhstan between April and June 2016. The survey was designed to be representative nationally and by urban and rural areas. The target population consisted of children (less than five years) and women of reproductive age (15 to 49 years).

4.2 SAMPLE SIZE AND SAMPLING STRATEGY

The sample size was based on the following assumptions: 95% confidence interval, 50% prevalence rate, precision of 0.055, average household size of 3.41, household response rate of 90% in rural areas and 75% in urban areas, individual response rate of 90%, and a design effect of 2, yielding a target sample size of 936 households in rural areas and 1,124 households in urban areas. Field teams collected data from 40 primary sampling units (PSUs) in each urban and rural stratum. In rural areas, 24 households were visited per PSU and in urban areas, 29 households were visited per PSU. In order to achieve the target sample size, the number of households selected was rounded up to 1,160 in urban areas and 960 in rural areas for a total number of 2,120 households.

In the first stage of sampling, 40 villages and electoral units from rural and urban areas, respectively, were selected as the PSUs using probability proportional to size (PPS) sampling where the measure of size equals the population count from the 2015 population estimates provided by the Kazakhstan Committee on Statistics. In the second stage of sampling, one health block was randomly selected from a complete listing of all health blocks serving each village or electoral unit. In the third stage of sampling, 24 children under five in rural areas and 29 in urban areas were randomly selected from a complete list of all children less than five years of age served by each health block. The primary caregiver of the selected child (i.e. the person, female or male, who fed the child on most days) was invited to participate in the survey. Up to two additional attempts were made to interview the eligible caregiver if s/he was absent at the time of the visit. There was no replacement of PSUs or households for refusals, lack of eligible participants, civil unrest, or inaccessibility due to natural disasters or other causes.

4.3 SURVEY INSTRUMENT

The survey instruments were adapted from GAIN's Fortification Assessment Coverage Toolkit (FACT), which was designed to assess fortification program coverage and utilization (Friesen, VM et al. 2017). Data were collected on demographic and socioeconomic status; education; housing conditions; recent infant and child mortality; water, sanitation, and hygiene (WASH) practice; food security; women's dietary diversity; infant and child feeding practices; maternal and child anthropometry; and coverage and consumption of fortified foods (see Questionnaire in Annex 1). All survey modules (i.e. question and indicator sets) were taken or adapted from validated guidelines where available (Aaron, Sodani, et al. 2016; Aaron, Strutt, et al. 2016).

4.4 ETHICAL CONSIDERATIONS AND SURVEY ADMINISTRATION PROCEDURES

Ethical clearance for the survey was obtained from the Institutional Review Board at the KAN (ВП-ЭК-1, March 25, 2016), the Ministry of Health and Social Development's (05-1-32/11478 of 5.04.2016), all 14 Oblast Health Departments, the Health Departments of Astana and Almaty Cities and Akimats in each oblast. Oral informed consent was obtained from the caregiver for herself/himself and the selected child and recorded on the survey questionnaire. Data were collected by trained enumerators under the supervision of experienced field supervisors. All survey instruments were contextualized and adapted to the local context then translated into Kazakh and Russian languages and back-translated into English to ensure correct meanings were retained. Survey instruments were pilot-tested prior to implementation to finalize language, wording, and flow of questions and response options. Interviews were conducted in Kazakh or Russian and data were collected on paper forms, which were reviewed daily by supervisors for completeness and correctness.

4.5 INDICATOR DEFINITIONS

<u>Indicators of risk</u>
Two indicators of risk that are associated with poor micronutrient intakes were used to assess the relationship between coverage and vulnerability. The risk indicators were:

- Rural residence – determined by reference to the census data used to draw the sample;

- Poverty – defined according to the multi-dimensional poverty index (MPI), which is a composite indicator constructed from indicators on living standards, education, and health and nutrition; households are classified as at risk of poverty if the MPI score is greater than or equal to one third (Alkire and Santos 2014);

<u>Indicators of coverage</u>

Four measures of coverage were defined according to the Tanahashi coverage framework (Tanahashi 1978) and reported as the proportion of households meeting the criteria out of the total number of surveyed households:

- Consumption of the vehicle – the household consumes the vehicle;
- Consumption of the fortifiable vehicle – the food vehicle used by the household that is industrially produced (i.e. not made at home);
- Consumption of the fortified vehicle – the food vehicle used by the household is fortified at any level (above intrinsic level for iron); and
- Consumption of the food vehicle that is fortified according to the national standard – the food vehicle used by the household is fortified in compliance with the national standards.

<u>Indicators of consumption and micronutrient contribution</u>

The daily quantity of food vehicle consumed per individual was estimated and used in conjunction with the fortification content results to determine the micronutrient contribution coming from consumption of fortified foods as a percentage of the estimated average requirement (EAR) and/or the recommended nutrient intake (RNI).

For salt and wheat flour:

The daily quantity consumed per individual household member was determined by a household assessment using the adult male equivalent (AME) method (Weisell and Dop 2012). The daily quantity of food vehicle consumed in the household was estimated based on the reported quantity purchased and the duration it lasted in the household. Each member of the household was assigned an age and sex-specific AME and the AMEs were summed together to calculate a household AME. Each individual AME was divided by the household AME and then multiplied by the quantity of food vehicle consumed by the household to calculate the quantity in grams of food vehicle consumed per day per individual household member. Individuals from households that reported not consuming the food vehicle or those with missing information were assigned zero for grams of food vehicle consumed per day. Children less than six months of age were excluded in the analyses.

For wheat flour only:

An individual assessment of the frequency and quantity of foods prepared from fortifiable wheat flour consumed in the past seven days was also conducted using a semi-quantitative food frequency questionnaire to quantify the total daily wheat flour consumed from all sources. This method was selected because the majority of people consume prepared wheat flour products outside the household and thus the AME alone would not reflect total daily wheat flour intake.

The respondent was asked to report whether s/he and the child consumed any of the 33 wheat flour containing foods on the list in the last 7 days. For foods they consumed, the frequency was asked and the portion size was estimated using a photo album for each food (see example in Annex 2). The grams of flour in each portion size reported being consumed was multiplied by the frequency of consumption to estimate the intake of flour for the individual per week, and then divided by seven to calculate intake per day. A cumulative total of wheat flour consumed in grams per day was obtained by summing all food items containing flour for the individual per day. For any of the 33 foods an individual did not consume or for missing (i.e. frequency or portion size), the grams consumed for that food item were assigned a zero.

The quantity in grams of food vehicle consumed per person per day was used to estimate the nutrient contribution from the fortified food vehicle (i.e. iodine from salt and iron from wheat flour) by multiplying it by a fortification exposure level. For the AME method, in households where the brand name of the food vehicle used was available, the household was assigned the mean nutrient level for that brand; where the brand was unknown, the household was assigned the mean nutrient level for the unbranded samples. For the amount of wheat flour consumed away from home (i.e. total amount consumed from individual assessment minus AME amount consumed), the weighted mean nutrient level of all branded and unbranded wheat flour was multiplied with the amount of flour each individual consumed daily to estimate the daily amount of iron consumed. The resulting two values for daily amount of iron consumed were added together to calculate the total daily amount of iron consumed. It should be noted that nutrient levels for iron in wheat flour were adjusted for intrinsic iron content thus results for wheat flour are for added iron from fortification only. Children less than six months of age were excluded in the analyses.

The nutrient contribution coming from consumption of fortified foods was then expressed as a percentage of the EAR and RNI for iodine from salt, and as a percentage of the RNI for iron from wheat flour. Percentage of EAR was used for iodine because it allows for comparison to the EAR cut-point method, which is recommended to be used when setting goals and evaluating the impact and safety of fortification for these nutrients (WHO and FAO, 2006). The EAR cut-point approach is not recommended for estimating prevalence of inadequate iron intakes among children and WRA because their requirements are not normally distributed; therefore, the percentage of RNI was estimated as an alternative for presenting the iron contribution coming from the fortified foods. EAR values were taken from the Institute of Medicine Dietary Reference Intakes (Food and Nutrition Board, 2001); RNI values were taken from World Health Organization and Food and Agriculture Organization, 2004, for iron bioavailability was assumed to be 12%.

4.6 DETERMINATION OF MICRONUTRIENT CONTENT AND FORTIFICATION STATUS

Fortification status was determined by analysis of food specimens collected from households. At the household, one sample of the main type of salt, wheat flour, and wheat flour bread was collected, if available. A qualitative spot test was done in the household to determine the presence of fortificant. For salt and wheat flour, if the spot test was positive, samples were taken for quantitative laboratory analyses to determine total nutrient content by brand. See Annex 6 for details on analytical methods (all methods are validated except for the qualitative iron spot test in bread made from wheat flour – the method is validated in wheat flour alone only). In addition, 20% of all food samples that tested negative were collected to verify the qualitative spot tests and to estimate the intrinsic levels of iron in unfortified wheat flour. All samples from the same brand were pooled to create a composite sample which was analyzed for total nutrient content[1]. See Tables 9 and 10 in Annex 4 for further details.

Households were classified as consuming the fortified vehicle if the sample collected in the household tested positive for the spot test. For salt and wheat flour, if no food sample was available for a spot test, then the household was classified based on the results from the quantitative analyses for the reported brand used. For wheat flour bread, if no sample was available for a spot test, then the household was classified as not fortified as no quantitative analyses were conducted on bread samples.

Households were classified as consuming the food vehicle that is fortified according to the national standard if the mean nutrient content of the reported brand was confirmed to comply with the range of the national standard based on results from the quantitative analyses. If the brand name was unavailable, then the mean value of all the unbranded samples was applied.

4.7 DATA MANAGEMENT AND ANALYSES

Double data entry was conducted using Microsoft Excel 2010. Data quality was ensured by interactive checking for consistency, range, and legal values. Data analyses were conducted using the Statistical Package for the Social Sciences (SPSS Inc. PASW Statistics for Windows, Version 18.0). Descriptive statistics were applied to assess the structure of the variables and indicators. Mean and its 95% confidence interval or median with interquartile range were calculated for each quantitative indicator. Frequency tables were constructed for qualitative indicators. Associations between indicators and living in urban or rural area were assessed using either adjusted chi-square p values for categorical variables or adjusted student's t-test for quantitative variables. All analyses were population weighted and account for the complex design of the stratified multi-stage cluster survey. The first set of weights was applied to present stratum specific, urban or rural, estimates. When combining urban and rural strata to develop national estimates, a second set of weights was applied in order to take into account the distribution of the urban and rural populations. P-values of 0.05 were considered statistically significant.

[1] Number of samples per brand ranged from 1 to 1,290 for salt and 1 to 228 for wheat flour.

4.8 LIMITATIONS

There were several limitations of the survey that are outlined below:

1. The results of the survey are representative of households with at least one child under five and are not representative of the entire population. Results for WRA are also not representative of all WRA in the country given that they were not randomly selected.

2. Due to the nature of collecting single samples of food vehicles from households, the number of single samples collected per brand and then pooled together to form a composite sample varied greatly depending on the brands found in the households; i.e., the number of single samples pooled for salt ranged from 1 to 1290 (median 18) and for wheat flour ranged from 1 to 228 (median 2). As a result, brands with few numbers of single samples may have higher variation than those with higher numbers.

3. Classification of food samples/brands by fortification content was done in accordance with the national standards; however, for wheat flour, the prescribed range for complying with the standard (i.e. 45-65 ppm) is too narrow to account for the natural variation in wheat flour assessed. As a result, the actual proportion of brands that were fortified according to the national standard and subsequently the household coverage of consumption of wheat flour that is fortified according to the national standard be underestimated.

4. The request that the household report the brand of food vehicle most recently purchased or received is subject to recall bias and may not be indicative of the usual brand used in the household.

5. The AME method used to estimate intake of food vehicles is an indirect approach that assumes intra-household food distribution is the same as the AME value for every member in household is based on the person's age, sex and physiological status. Moreover, the individual food frequency recall method used to estimate intake of wheat flour foods has not yet been validated. Both methods are subject to recall bias.

6. Results

6.1 SURVEY POPULATION DEMOGRAPHICS

In total, in 2,004 out of the 2,120 selected households, an eligible caregiver-child pair was available at the time of the interview and consented to participate in the survey, resulting in a response rate of 94.5%. An overview of the household and demographic characteristics of the survey sample is presented in Table 1. Household size and household dependency ratio were higher in rural areas (5.9 and 1.1, respectively) than in urban areas (4.9 and 0.9, respectively). Rural households were more likely to have a household member of school-age not attending school (22.7% vs. 12.7%). None of the households were categorized as at risk of poverty according to the MPI therefore results were not stratified by poverty status. This low rate of poverty is in line with recent estimates using the MPI (Alkire and Santos 2014).

Table 1: Household and demographic characteristics of the survey sample, Kazakhstan, 2016[1]

Variable	Mean/Percentage (95% CI)			P-value†
	National N=2004	Urban N=1058	Rural N=946	
Household				
Household size (n), mean	5.36 (5.27, 5.44)	4.92 (4.81, 5.02)	5.93 (5.1, 6.05)	<0.001
Household dependency ratio[2]	1.0 (1.0, 1.0)	0.9 (0.9, 0,9)	1.1 (1.0, 1.1)	<0.001
MPI score ≥ 0.33, %[3]	0.0 (0.0, 0.2)	0.0 (0.0, 0.2)	0.0 (0.0, 0.4)	0.317
Any household member 5-14 years not currently attending school, %	17.0 (15.3, 18.6)	12.7 (10.7, 14.8)	22.7 (20.1, 25.3)	<0.001
Caregiver				
Age (years), mean	30.4 (30.1, 30.6)	30.3 (30.0, 30.7)	30.4 (30.1, 30.9)	0.584
< 5 years education, %	0.1 (0.0, 0.3)	0.0 (0.0, 0.2)	0.2 (0.0, 0.6)	0.500
Child				
Age (months), mean	27.3 (26.6, 28.1)	26.9 (25.9, 28.0)	27.9 (26.8, 28.9)	0.219
Sex, female, %	48.6 (46.4, 50.8)	47.9 (44.9, 51.0)	49.5 (46.4, 52.6)	0.496

Abbreviations: CI, confidence interval; MPI, multi-dimensional poverty index

[1] All values are mean or percent as indicated, and are weighted to correct for unequal probability of selection.

[2] Household dependency ratio = (Number of household members below 15 years old and above 64 years old) / (Number of household members between 15 and 64 years old)

[3] MPI ≥ 0.33 is considered at risk of acute poverty

† P-value calculated using the independent samples t-test, adjusted for unequal probability of selection

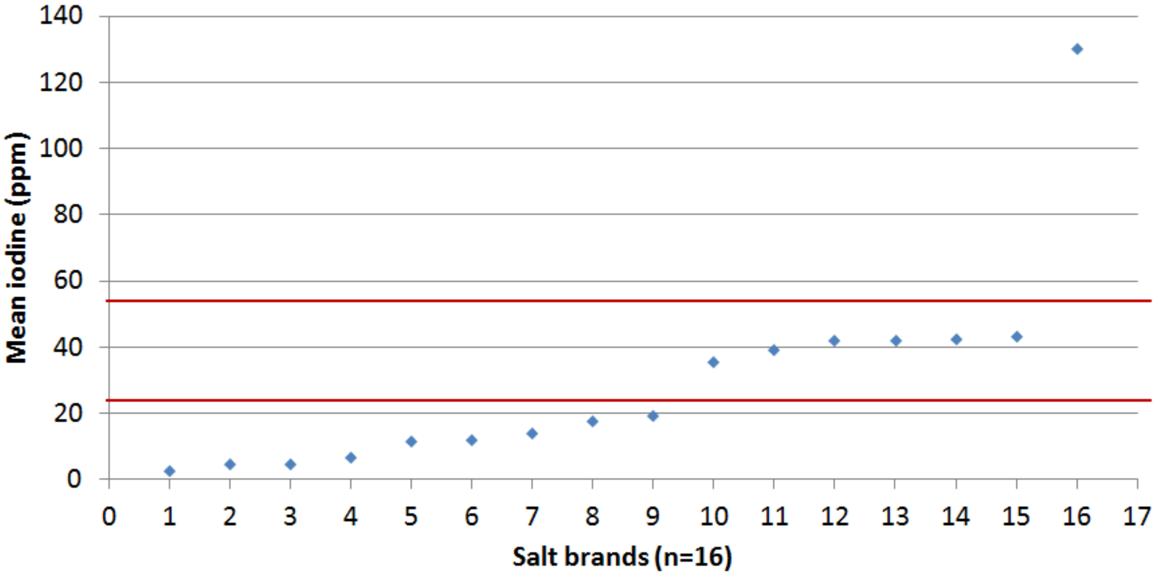
6.2 MICRONUTRIENT CONTENT OF FOOD SAMPLES

The micronutrient content of household wheat flour and salt samples by brand at the national level compared to national standards is presented in Figure 1. Further breakdown of these results by oblast and brand can be found in Annex 4, Tables 8-10.

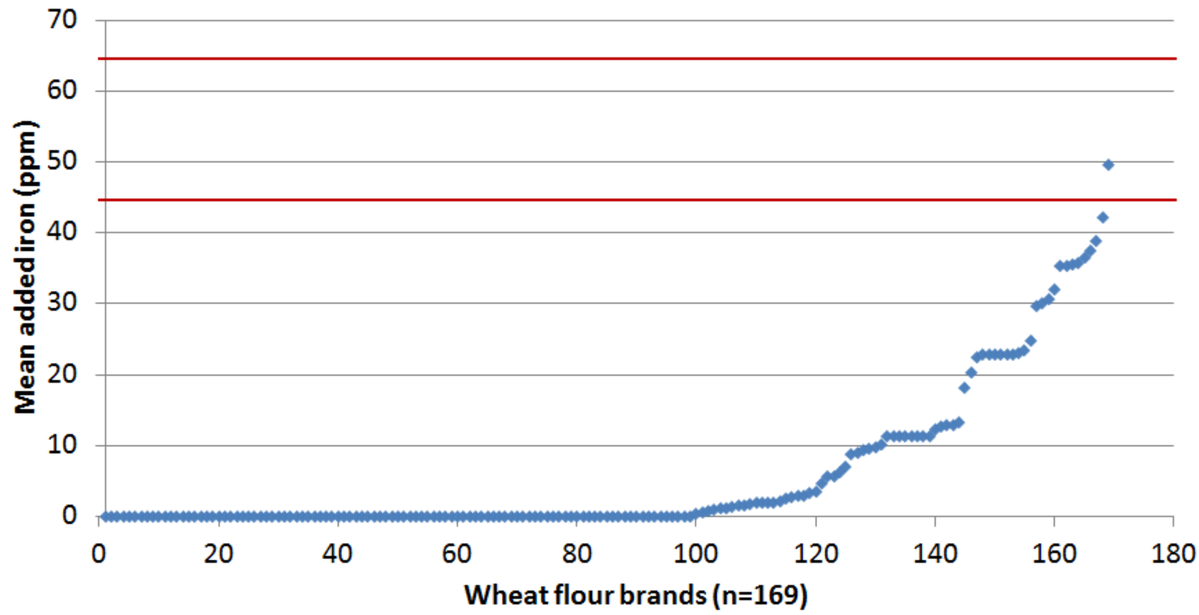
Among the 16 salt brands that were identified, all brands were found to contain added iodine to some extent, while only six brands (38%) contained the content of iodine required according to the national standard (i.e. 25-55 ppm) and one brand contained iodine in excess of the upper limit of the standard.

Among the 169 wheat flour brands that were identified, 99 brands (58%) did not contain any added iron. Among the 70 brands that were fortified, only one brand (1%) contained the content of added iron required according to the national standard (i.e. 45-65 ppm) while the remaining 69 brands (41%) contained some added iron but in amounts below 45 ppm.

Figure 1: Micronutrient content of each brand of salt (A) and wheat flour (B) compared to national standards, Kazakhstan, 2016



A.



B

Continuous red lines indicate the range prescribed in the most recent national standards (ST RK 1741-2008 for fortified wheat flour and ST RK GOST R 51575-2003 for iodized edible salt), i.e. for salt, 25-55 ppm iodine and for wheat flour, 45-65 ppm added iron.

6.3 HOUSEHOLD COVERAGE OF FORTIFIED FOODS

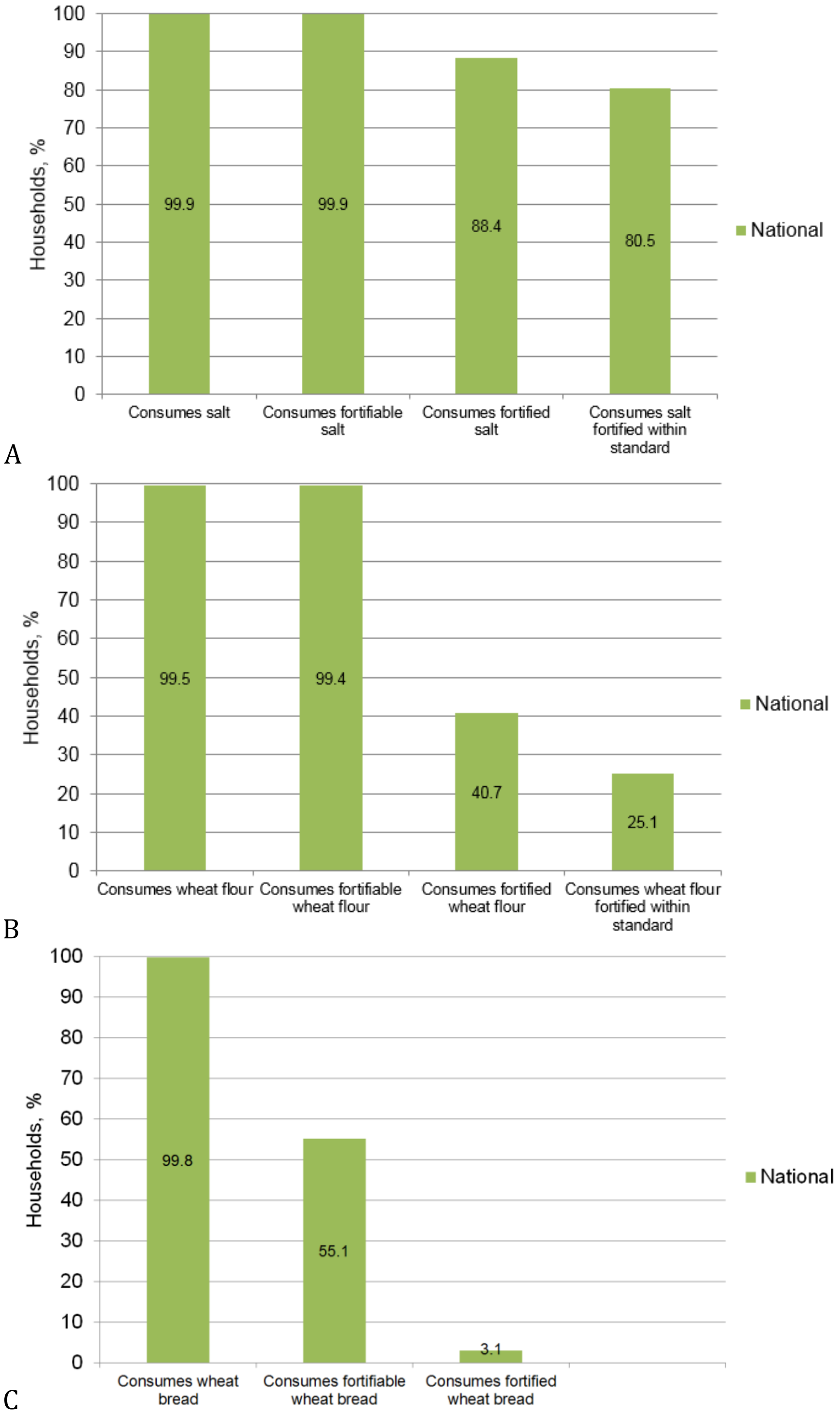
Results on household coverage of fortified foods are presented at the national level in Figure 1 and stratified by urban and rural in Figure 2. These results are shown in table format in Annex 3.

Consumption of salt and wheat flour, generally and in the fortifiable form (i.e. industrially produced), is universal in Kazakhstan (>99% of households). Nationally, iodized salt is consumed by 88% of households and iodized salt fortified according to the national standard is consumed by 81% of households. Coverage of iodized salt was lower among rural households compared to urban households (85% vs. 91%) as was coverage of iodized salt fortified according to the national standard (78% vs. 83%).

Fortified wheat flour was consumed by 41% of households nationally, but only 25% of households consumed wheat flour fortified according to the national standard. Coverage of fortified wheat flour was lower among rural households compared to urban households (33% vs. 47%), as was coverage of wheat flour fortified according to the national standard (16% vs. 32%).

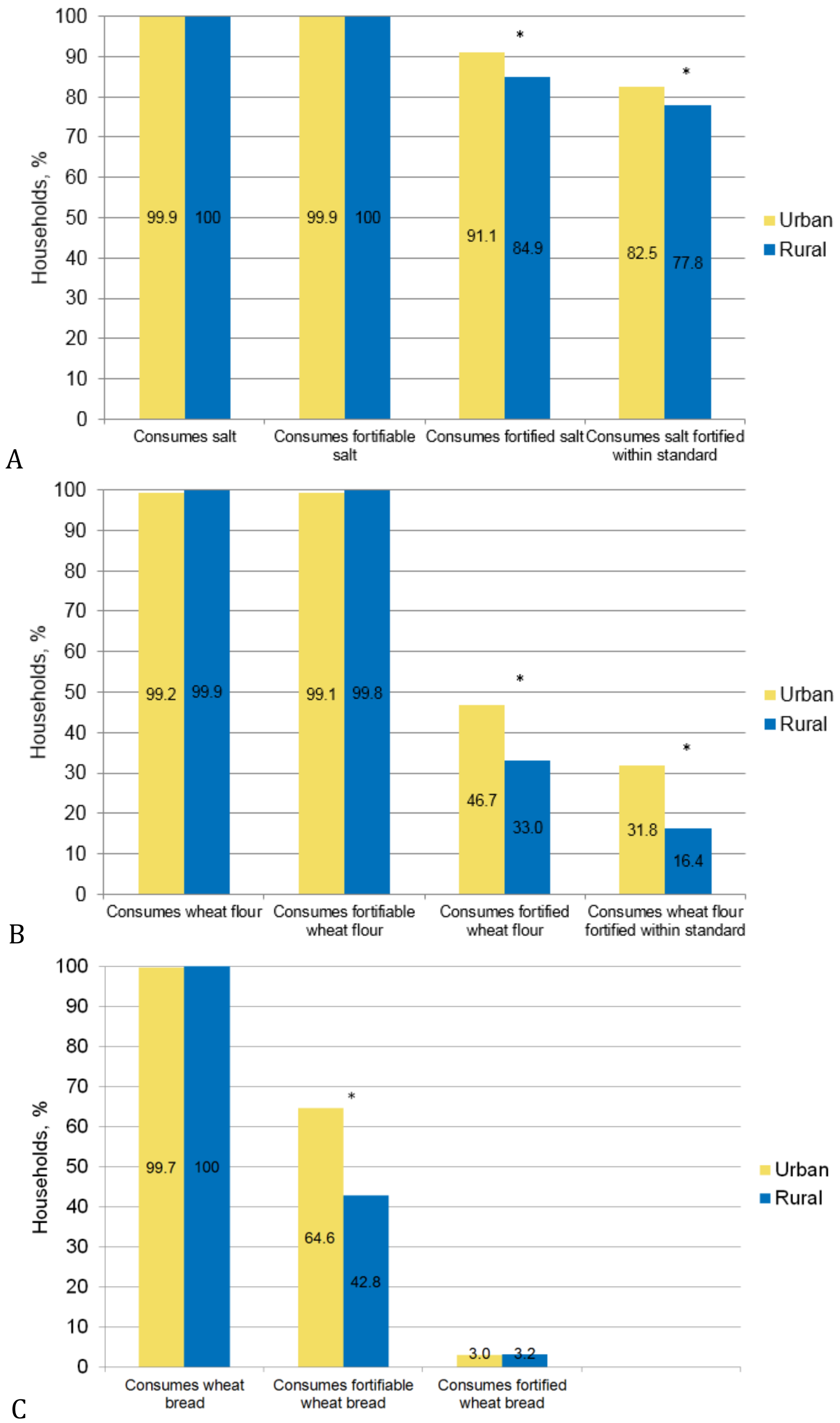
Nearly all households consumed industrially produced bread (>99%) but only 55% consumed bread made from fortifiable wheat flour (i.e. white/premium or first grade flours that fall under the mandatory fortification program) and only 3% consumed bread made from fortified wheat flour.

Figure 2: National household coverage of (A) salt, (B) wheat flour, and (C) wheat bread, Kazakhstan, 2016



"Consumes" refers to households that reported using this food at home. "Consumes fortifiable" refers to households that reported consuming a food vehicle that was not made at home and is assumed to be industrially processed (for wheat flour this refers only to white/premium or first grade flours; for bread this refers to any bread made from white/premium or first grade wheat flour). "Consumes fortified" refers to households that consumed a food that was confirmed to be fortified by spot test or quantitative laboratory analyses. "Consumes fortified within standard" refers to households that consumed a food that was confirmed to be fortified in accordance with the national standards by quantitative laboratory analyses (i.e. 45-65 ppm of total iron for wheat flour and 25-65 ppm iodine for salt).

Figure 3: Household coverage of (A) salt, (B) wheat flour and (C) wheat flour bread stratified by urban and rural, Kazakhstan, 2016



"Consumes" refers to households that reported using this food at home. "Consumes fortifiable" refers to households that reported consuming a food vehicle that was not made at home and is assumed to be industrially processed (for wheat flour this refers only to white/premium or first grade flours; for bread this refers to any bread made from white/premium or first grade wheat flour). "Consumes fortified" refers to households that consumed a food that was confirmed to be fortified by spot test or quantitative analyses. "Consumes fortified within standard" refers to households that consumed a food that was confirmed to be fortified in accordance with the national standards by laboratory analyses (i.e. 45-65 ppm of total iron for wheat flour and 25-65 ppm iodine for salt). * P-value <0.05.

6.4 CONSUMPTION OF FORTIFIABLE FOODS

Household level assessment of consumption using the adult male equivalent method

Daily apparent salt and wheat flour consumption by population group and place of residence based on the household assessment using the AME method is presented in Table 2.

Daily apparent consumption of fortifiable salt among children ranged from 1.9 to 3.2 g/day and was the lowest in the age group of 9-11 months and highest in the age group of 24-59 months. Women of reproductive age apparently consumed 6.7 g/day of fortifiable salt. The daily apparent consumption of fortifiable salt was significantly higher among all population groups from rural areas compared with those from urban areas with the exception of children 6-8 months.

Daily apparent consumption of fortifiable wheat flour among children ranged from 21.2 to 37.0 g/day and was the lowest in the age group of 6-8 months and highest in the age group of 24-59 months. Women of reproductive age apparently consumed 79.2 g/day of fortifiable wheat flour. The daily consumption of fortifiable wheat flour was significantly higher among rural households compared with those from urban households by nearly two-fold across all populations.

Table 2: Daily apparent salt and wheat flour consumption by household assessment using adult male equivalent method stratified by population group, Kazakhstan, 2016[1]

Variable	N	Median (25%, 75%)			P-value†
		National	Urban	Rural	
Fortifiable salt, g/day[2]					
Children					
6-8 months	127	2.1 (1.5, 2.9)	2.1 (1.5, 3.0)	2.1 (1.6, 2.9)	0.511
9-11 months	127	1.9 (1.5, 2.8)	1.7 (1.4, 2.4)	2.3 (1.5, 3.6)	0.001
12-23 months	455	2.7 (1.9, 3.8)	2.6 (1.8, 3.7)	2.9 (2.1, 3.9)	0.037
24-59 months	1100	3.2 (2.3, 4.6)	3.0 (2.2, 4.4)	3.6 (2.7, 4.9)	<0.001
Women of reproductive age					
15-49 years	1980	6.7 (4.9, 9.5)	6.4 (4.6, 8.9)	7.3 (5.4, 10.2)	<0.001
Fortifiable wheat flour, g/day[3]					
Children					
6-8 months	127	21.2 (8.3, 56.3)	10.9 (5.7, 22.5)	53.9 (25.2, 71.7)	<0.001
9-11 months	127	23.3 (10.2, 43.8)	14.7 (5.5, 28.6)	43.8 (30.3, 61.1)	<0.001
12-23 months	456	32.2 (14.9, 66.9)	19.9 (10.6, 40.7)	56.0 (30.1, 89.6)	<0.001
24-59 months	1100	37.0 (18.4, 83.8)	24.4 (12.3, 42.4)	78.4 (39.7, 120.4)	<0.001
Women of reproductive age					
15-49 years	1981	79.2 (36.3, 172.8)	49.0 (24.0, 89.1)	157.8 (83.2-238.9)	<0.001

[1] All values are median as indicated and are weighted to correct for unequal probability of selection.
[2] Fortifiable refers to any salt that was not made at home and is assumed to be industrially processed.
[3] Fortifiable refers to any white/premium or first grade flour that was not made at home any is assumed to be industrially processed.
† P-value calculated using the independent samples t-test, adjusted for unequal probability of selection.

Individual level assessment of consumption using the food frequency questionnaire method

Daily wheat flour consumption by population group and place of residence, calculated using the individual assessment method, is presented in Table 3.

Daily consumption of fortifiable wheat flour among children ranged from 2.0 to 95.9 g/day and was the lowest in the age group of 6-8 months and highest in the age of 24-59 months. Women of reproductive age consumed 174.2 g/day of fortifiable wheat flour. The amount of fortifiable wheat flour consumed daily was significantly higher among children 24-59 months and women of reproductive age from rural areas (113.6 g/day and 198.3 g/day, respectively) compared to those from urban areas (83.3 g/day and 153.3 g/day, respectively). No differences in intake were observed between urban and rural groups among younger children.

Table 3: Daily wheat flour consumption based on individual assessment using food frequency questionnaire method stratified by population group, Kazakhstan, 2016[1]

Variable	N	Median (25%, 75%)			P-value†
		National	Urban	Rural	
Fortifiable wheat flour, g/day[2]					
Children					
6-8 months	127	2.0 (0.0, 16.4)	1.0 (0.0, 17,.9)	2.0 (0.0, 14.0)	0.355
9-11 months	127	28.8 (14.2, 48.1)	30.1 (15.5, 50.5)	27.1 (13.5, 47.3)	0.455
12-23 months	456	63.6 (43.1, 93.4)	64.3 (42.9, 92.4)	62.7 (43.2, 96.2)	0.273
24-59 months	1100	95.9 (62.0, 142.7)	83.3 (54.0, 126.3)	113.6 (80.7, 152.1)	<0.001
Women of reproductive age					
15-49 years	1981	174.2 (108.7, 57.4)	153.3 (94.4, 234.3)	198.3 (133.2, 283.4)	<0.001

[1] All values are median as indicated and are weighted to correct for unequal probability of selection.
[2] Fortifiable refers to any white/premium or first grade flour that was not made at home any is assumed to be industrially processed.
† P-value calculated using the independent samples t-test, adjusted for unequal probability of selection.

6.5 MICRONUTRIENT CONTRIBUTION FROM FORTIFIED FOODS

Household level assessment of micronutrient contribution using the adult male equivalent method

Iodine contributions from consumption of fortified salt per the AME method are expressed as a percentage of EAR by population group and presented in Table 4.

Iodized salt was estimated to contribute 149.0% of the EAR for iodine among children 12-23 months, 190.4% among children 24-59 months, and 267.9% among women of reproductive age, nationally. Findings were similar across both rural and urban households for children, while iodine contribution from salt was higher among women of reproductive age from rural households compared to those from urban households (277.4% vs. 255.0%, respectively) due to higher consumption patterns.

Table 4: Iodine contribution from fortified salt expressed as percentage of estimated average requirements (EAR) based on household assessment using adult male equivalent method stratified by population group, Kazakhstan, 2016

Variable	N	Median (25%, 75%)			P-value†
		National	Urban	Rural	
Salt, % EAR of iodine[1]					
Children					
12-23 months	455	149.0 (79.8, 226.2)	132.5 (76.0, 214.1)	165.6 (88.5, 233.3)	0.126
24-59 months	1100	190.4 (123.2, 278.6)	183.3 (123.5, 277.9)	204.6 (123.2, 283.4)	0.119
Women of reproductive age					
15-49 years	1980	267.9 (162.0, 389.8)	255.0 (161.7, 373.9)	277.4 (162.8, 406.7)	0.011

[1] The iodine EAR for children 12-59 months is 65 µg/day and for women 15-49 years is: 95 µg/day as per the US IOM 2001.
† P-value calculated using the independent samples t-test, adjusted for unequal probability of selection.

Iodine and iron contributions from consumption of fortified salt and wheat flour per the AME method are expressed as a percentage of RNI by population group and presented in Table 5.

Iodized salt was estimated to contribute 74.2% of the RNI for iodine among children 6-8 months, 73.6% among children 9-11 months, 107.6% among children 12-23 months, 137.5% among children 24-59 months, and 169.7% among women of reproductive age nationally. Findings were similar across both rural and urban households for children, while iodine contribution from salt was higher among women of reproductive age from rural households compared to those from urban households (175.7% vs. 161.5%, respectively) due to higher consumption patterns.

Fortified wheat flour was estimated to provide 1.3-1.8% of the RNI for iron among children 6-11 months, 2.3-3.9% among children 12-59 months, and 1.4% among women of reproductive age. Iron contribution from fortified wheat flour was higher among children 24-59 months and women of reproductive age from urban households compared to those from rural households (4.3% vs. 3.6%, and 1.6% vs. 1.3%, respectively) which may be attributed to better quality of fortification of the wheat flour consumed since daily intakes were lower.

Table 5: Iodine and iron contribution from fortified salt and wheat flour expressed as percentage of recommended nutrient intake (RNI) based on household assessment using adult male equivalent method stratified by population group, Kazakhstan, 2016

Variable	N	Median (25%, 75%)			P-value†
		National	Urban	Rural	
Salt, % RNI of iodine[1]					
Children					
6-8 months	127	74.2 (36.9, 122.5)	72.8 (39.1, 117.1)	77.6 (33.5, 140.0	0.210
9-11 months	127	73.6 (46.1, 113.7)	71.9 (52.7, 97.6)	75.7 (39.4, 126.5)	0.104
12-23 months	455	107.6 (57.6, 163.4)	95.7 (54.9, 154.6)	119.6 (63.9, 168.5)	0.129
24-59 months	1100	137.5 (89.0, 201.2)	132.4 (89.2, 200.7)	147.8 (89.0, 204.7)	0.119
Women of reproductive age					
15-49 years	1980	169.7 (102.6, 246.9)	161.5 (102.4, 236.8)	175.7 (103.1, 257.6)	0.011
Wheat flour, % RNI of iron[2]					
Children					
6-8 months	127	1.8 (0.3, 5.5)	2.2 (0.3, 5.3)	1.2 (0.1, 10.3)	0.065
9-11 months	127	1.3 (0.3, 5.2)	1.2 (0.1, 5.0)	1.4 (0.5, 6.6)	0.055
12-23 months	456	2.3 (0.2, 8.5)	3.1 (0.3, 8.6)	2.0 (0.0, 8.0)	0.084
24-59 months	1100	3.9 (0.4, 14.0)	4.3 (0.3, 13.3)	3.6 (0.6, 18.4)	<0.001
Women of reproductive age					
15-49 years	1982	1.4 (0.1, 5.5)	1.6 (0.1, 5.1)	1.3 (0.2, 6.7)	<0.001

[1] The iodine RNI for children 6-59 months is 90 µg/day and for women is: 150 µg/day (15-49 years) as per the World Health Organization 2004.

[2] The iron RNI for children is 7.7 mg/day (6-11 months), 4.8 mg/day (12-47 months) and 5.3 mg/day (48-59 months), and for women is 25.8 mg/day (15-18 years) and 24.5 mg/day (19-50 years), assuming 12% bioavailability, as per the World Health Organization 2004.

† P-value calculated using the independent samples t-test, adjusted for unequal probability of selection.

Individual level assessment of micronutrient contribution using the food frequency questionnaire method

Iron contribution from the calculated consumption of fortified wheat flour per the individual assessment method is expressed as a percentage of RNI by population group and presented in Table 6.

Fortified wheat flour was estimated to provide 1.7-4.9% of the RNI for iron among children 6-11 months, 16.7-25.1% among children 12-59 months, and 9.4% among women of reproductive age. Iron contribution from fortified wheat flour was higher among children 24-59 months and women of reproductive age from rural households compared to those from urban households (29.7% vs. 22.0%, and 10.7% vs. 8.3%, respectively) due to higher consumption patterns.

Table 6: Iron contribution from fortified wheat flour expressed as percentage of recommended nutrient intake (RNI) based on individual assessment stratified by population group, Kazakhstan, 2016[1,2]

Variable	N	Median (25%, 75%)			P-value†
		National	Urban	Rural	
Wheat flour, % RNI of iron[3]					
Children					
6-8 months	127	1.7 (0.0, 3.6)	1.2 (0.0, 3.6)	2.2 (0.0, 4.8)	0.054
9-11 months	127	4.9 (2.4, 8.2)	5.2 (2.7, 8.7)	4.6 (2.3, 8.1)	0.455
12-23 months	456	16.7 (11.4, 25.3)	16.6 (11.0, 25.0)	16.8 (11.6, 26.3)	0.186
24-59 months	1100	25.1 (16.7, 36.9)	22.0 (14.8, 32.1)	29.7 (21.2, 40.6)	<0.001
Women of reproductive age					
15-49 years	1981	9.4 (5.9, 13.9)	8.3 (5.1, 12.6)	10.7 (7.2, 15.3)	<0.001

[1] All values are median as indicated and are weighted to correct for unequal probability of selection.

[2] The iron RNI for children is 7.7 mg/day (6-11 months), 4.8 mg/day (12-47 months) and 5.3 mg/day (48-59 months), and for women is 25.8 mg/day (15-18 years) and 24.5 mg/day (19-50 years), assuming 12% bioavailability, as per the World Health Organization, 2004.

† P-value calculated using the independent samples t-test, adjusted for unequal probability of selection.

7. Key findings and recommendations

The findings of this survey provide population representative data on coverage and performance of the salt and wheat flour fortification programs nationally and in urban and rural areas of Kazakhstan among children under five and women of reproductive age, as well as estimates of the current contribution of these fortified foods to dietary intakes of iodine and iron. In summary, both food vehicles are universally consumed in a fortifiable form that should be fortified under the current mandatory legislation. The salt iodization program is making significant contributions to the iodine intakes in the target populations, while wheat flour fortification has potential to increase iron intakes across the population but the program is currently weak. Improvements are needed for the wheat flour program to reach its full potential as fortification adequacy remains a concern for both wheat flour and industrially produced bread made from fortifiable wheat flour.

Overall, increased efforts are needed to improve quality assurance and quality control of wheat flour fortification at production level to better address under fortification. The salt iodization program requires further analysis to examine whether the current standard may be too demanding for the conditions of the fortification process. Furthermore, enforcement and monitoring of fortification must be strengthened to increase availability of fortified foods in the market to maximize impact at household level. For full implementation of the Laws of the Republic of Kazakhstan on mandatory fortification of salt and wheat flour, and to find solutions to issues around fortification quality that were identified in the survey, the following recommendations are suggested.

1. Request the National Coordination Council for Health Protection under the Government of the Republic of Kazakhstan and the National Commission for Women and Family and Demographic Policy under the President of the Republic of Kazakhstan to support the following activities:
    - arrange inter-agency coordination and cooperation of all key partners on flour fortification and salt iodization;
    - discuss mechanisms to facilitate the purchase of premix for flour fortification;
    - ensure the state procurement of wheat flour and products made from wheat flour (e.g. bread, pasta) and salt for its social programs is from fortified sources;
    - include the production volume of fortified food vehicles (i.e. wheat flour and salt) to the list of state statistical reporting; and
    - implement harmonized standards and relevant regulations for wheat flour fortification with countries with which fortified products are imported/exported.
2. Request local authorities (i.e. Akimats at regional, city and district levels) to support and monitor wheat flour producers to comply with fortification regulations, and producers of wheat flour products (e.g. bread, pasta) to use fortified wheat flour.
3. Support improved quality assurance and quality control procedures for wheat flour and salt producing enterprises, and improved enforcement and monitoring of compliance with fortification legislation to increase the availability of foods fortified according to the national standard at market and household levels.

These results will be shared with nutrition stakeholders in the country to further guide programming efforts and nutrition policy recommendations.

8. References

Aaron, Grant J., Prahlad R. Sodani, Rajan Sankar, John Fairhurst, Katja Siling, Ernest Guevarra, Alison Norris, and Mark Myatt. 2016. “Household Coverage of Fortified Staple Food Commodities in Rajasthan, India.” PloS One 11 (10): e0163176. doi:10.1371/journal.pone.0163176.

Aaron, Grant J., Nicholas Strutt, Nathaniel Amoh Boateng, Ernest Guevarra, Katja Siling, Alison Norris, Shibani Ghosh, et al. 2016. “Assessing Program Coverage of Two Approaches to Distributing a Complementary Feeding Supplement to Infants and Young Children in Ghana.” PloS One 11 (10): e0162462. doi:10.1371/journal.pone.0162462.

Alkire, Sabina, and Maria Emma Santos. 2014. “Measuring Acute Poverty in the Developing World: Robustness and Scope of the Multidimensional Poverty Index.” World Development 59 (July): 251–74. doi:10.1016/j.worlddev.2014.01.026.

AOAC International. 1995. Official Methods of Analysis of AOAC International. 16th ed. Method 965.09. The Association, Arlington, VA.

DeMaeyer E. M., Lowenstein F. W., Thilly C. H. 1979. The Control of endemic goitre. WHO, Geneva, 1979, 89 p.

Food and Nutrition Board, Institute of Medicine. 2001. Dietary Reference Intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc. Washington (DC): National Academies Press.

Friesen, VM, Aaron, GJ, Myatt, M, and Neufeld, LM. 2017. “Assessing Coverage of Population-Based and Targeted Fortification Programs Using the Fortification Assessment Coverage Toolkit (FACT): Background, Toolkit Development, and Supplement Overview.” Journal of Nutrition 147 (Suppl): 981S – 3S.

Interstate standard GOST 30178-96. Raw material and food-stuffs. Atomic absorption spectrometric method of determination of toxic elements. Official publication. Interstate Council for Standardization, Metrology and Certification. Minsk, 1996 (Reprint 2003, Date of update: 02/12/2016), 11 p. (in Russian).
http://meganorm.ru/Index2/1/4294825/4294825120.htm

Kazakh Academy of Nutrition. 2011. “National Study of Micronutrient Deficiencies in Kazakhstan (Russian).” Almaty, Kazakhstan: Kazakh Academy of Nutrition, Final Report.

MBI Kits International 2016. “Improved Iodised Salt Field Test Kit for salt fortified with potassium iodate only” (MBI Kits International, Chennai, India). Expiry data for the Test Kit – September 2016.

Sharmanov T., Tsoy I., Tazhibajev Sh., Kulmurzayeva L., Ospanova F., Karsybekova N., Muzafarov R., Kosbayeva A., Nurgabilova A., van der Haar F. 2008. "IDD Elimination through

Universal Salt Iodization in Kazakhstan." IDD Newsletter, February 2008, p. 4-8. http://kan-kaz.org/english/files/pages_from_IDD_NL_Feb2008.pdf

ST RK 1741-2008. State Standard of the Republic of Kazakhstan. Fortified (enriched) bakery wheat flour. General specifications. (In Russian).

ST RK GOST R 51575-2003. State Standard of the Republic of Kazakhstan. Iodized edible salt. Methods for determination of iodine and sodium thiosulphate. (In Russian).

Tanahashi, T. 1978. “Health Service Coverage and Its Evaluation.” Bulletin of the World Health Organization 56 (2): 295.

The Code of the Republic of Kazakhstan 2009. "On the health of the people and the health system" enacted on September 18, 2009

The Law of Republic of Kazakhstan 2003. “On Prevention of Iodine Deficiency Disorders” enacted on 14 November 2003

The USAID Micronutrient program. 2000. 4. Manual for wheat flour fortification with iron. Part 3. Analytical methods for monitoring wheat flour fortification with iron. Compiled by Ritu Nalubola and Penelope Nestel. MOST, The USAID Micronutrient program, 2000, 54 p.

Weisell, Robert, and Marie Claude Dop. 2012. “The Adult Male Equivalent Concept and Its Application to Household Consumption and Expenditures Surveys (HCES).” Food and Nutrition Bulletin 33 (3 Suppl): S157–62. doi:10.1177/15648265120333S203.

World Health Organization, and Food and Agriculture Organization. 2004. “Vitamin and Mineral Requirements in Human Nutrition, Second Edition.” Geneva, Switzerland. http://www.who.int/nutrition/publications/micronutrients/9241546123/en/.

World Health Organization, and Food and Agriculture Organization. 2006. Guidelines on Food Fortification with Micronutrients. http://www.who.int/nutrition/publications/guide_food_fortification_micronutrients.pdf.

9. Annexes

1: QUESTIONNAIRE

KAZAKHSTAN FACT COVERAGE SURVEY 2016

HOUSEHOLD QUESTIONNAIRE

dateint	Date of interview	DD / MM / YY ☐☐ / ☐☐ / ☐☐			
teamid	Team identifier	☐	intid	Interviewer identifier	☐☐
oblastid	Oblast identifier	Akmola…………01 Aktobe...………....02 Almaty Obl.…….03 Atyrau ………….04 East Kaz.………05 Karaganda.… ...06	Kostanay…………07 Kzylorda…………..08 Mangystau............09 North Kaz...……...10 Pavlodar……. ……11 South Kaz..……….12	West Kaz..………..13 Zhambyl.………...14 Astana City.……..15 Almaty City...........16	
clustnam	Cluster name	____________________			
clustid	Cluster identifier	☐☐	clusttype	Cluster type	Urban………1 Rural………..2
hhid	Household identifier	☐☐			

Good morning / Good evening Madam / Sir, /

My name is [NAME OF INTERVIEWER] and I work for Kazakh Academy of Nutrition (KAN). We are currently conducting a survey on the coverage of fortified foods and your household was randomly selected to participate in the survey. Specifically, [NAME OF CHILD] who lives in this household was selected. I would like to interview the mother or caregiver of this child. Is she/he available?

The first part of the interview will be about the composition of the household, including all its members. Then I will ask the mother/caregiver of the child some questions about what she and the child ate yesterday and foods purchased and prepared in the household, like salt, wheat flour, and bread, and if available ask for a small sample. At the end I will measure the arm circumference of the mother/caregiver and the child to assess their nutritional status. The questions to you will take about 45 minutes.

Do you agree to participate in the interview?

cons1	Oral consent from mother/ caregiver obtained?	Yes………… 1 No………….. 2	If **yes**, start. If **no**, stop here.

FILL IN AFTER COMPLETING QUESTIONNAIRE		
visitno	Number of attempts to visit household (up to three visits)	☐
outhh	Outcome of household questionnaire	Completed...1 Refused..2 No eligible respondent at home at time of visit(s)...............................3 Eligible respondent incapacitated or intoxicated……………………..4 Dwelling vacant for extended period of time…………………………5 Dwelling destroyed……………………………………………………6 Other:______________________________.............99
Supervisor check completed (signature): ______________________________		

HOUSEHOLD ROSTER						
Please give me the names of the persons who usually live in your household. This will include anybody who sleeps in this household regularly and eats from the same pot of food. Start with the head of the household.						
Line no. (lnr)	A. Name	B. Sex (sex)	C. Age *(years OR months)* *Record in months if <5 years or <60 months*		ONLY for persons aged ≥ 5 years	
			Years (agey)	Months (agem)	D. Currently attending school or university/ college? (sch)	E. 5 or more years of education? (edu)
01	Head of household	M……….1 F………..2			Yes………1 No……….2	Yes………1 No……….2
02		M……….1 F………..2			Yes………1 No……….2	Yes………1 No……….2
03		M……….1 F………..2			Yes………1 No……….2	Yes………1 No……….2
04		M……….1 F………..2			Yes………1 No……….2	Yes………1 No……….2
05		M……….1 F………..2			Yes………1 No……….2	Yes………1 No……….2
06		M……….1 F………..2			Yes………1 No……….2	Yes………1 No……….2
07		M……….1 F………..2			Yes………1 No……….2	Yes………1 No……….2
08		M……….1 F………..2			Yes………1 No……….2	Yes………1 No……….2
09		M……….1 F………..2			Yes………1 No……….2	Yes………1 No……….2
10		M……….1 F………..2			Yes………1 No……….2	Yes………1 No……….2
11		M……….1 F………..2			Yes………1 No……….2	Yes………1 No……….2
Note: Add a new page if more people in the household						

Check the roster for completion!

childlnr	Child line number (from roster)	
carelnr	Caregiver/Mother line number (from roster)	

ETHNICITY			
N°	QUESTIONS	ANSWERS	SKIPS
et1	What is your ethnicity? *(CIRCLE ONLY **ONE** ANSWER.)*	Kazakh………………………………………..1 Russian……………………………………..…2 Ukrainian…………………………………..3 Uzbek……………………………………….…4 Uygur…………………………………………5 German………………………………………6 Korean………………………………………..7 Don't know…………………………...…..88 Other:_______________________...........99	

HOUSEHOLD CHARACTERISTICS AND ASSETS			
N°	QUESTIONS	ANSWERS	SKIPS
hc1	Does your household have electricity? *(CIRCLE ONLY **<u>ONE</u>** ANSWER)*	Yes…………………………………………..1 No…………………………………………….2	
hc2	What fuel does your household mainly use for cooking? *(CIRCLE ONLY **<u>ONE</u>** ANSWER)*	Electricity Gas Kerosene ……..………1 Dung Wood Charcoal Other ……..………2	
hc3	What is the main material of the floor of the dwelling? *(OBSERVATION)* *(CIRCLE ONLY **<u>ONE</u>** ANSWER)*	Tiles Concrete Wood ……..…………1 Dirt Earth / Sand Dung Other ………………2	
hc4	Does your household or anyone in the household own a … ? ***(PROMPT FOR EACH ITEM**; RECORD ALL ITEMS OWNED BY HOUSEHOLD OR A MEMBER...)* *(CIRCLE ONLY **<u>ONE</u>** ANSWER FOR EACH ITEM.)*	A. Radio Yes………1 No……….2	
		B. Television Yes………1 No………..2	
		C. A mobile or non-mobile telephone Yes……1 No……….2	
		D. Bicycle Yes………1 No………..2	
		E. Motorcycle Yes………1 No………..2	
		F. Refrigerator Yes………1 No………..2	
		G. Car or truck Yes………..1 No………...2	

WATER, SANITATION, AND HYGIENE (WASH)			
N°	QUESTIONS	ANSWERS	SKIPS
w1	What is the main source of drinking water for the members of your household? *(CIRCLE ONLY **ONE** ANSWER)*	Piped water into dwelling Piped water into yard / plot / compound Public tap or standpipe Borehole or pump Protected dug well Protected spring or rainwater Bottled water ………1 Unprotected dug well Unprotected spring Tanker truck River or stream Dam, lake, or pond Canal or irrigation channel Other ………2	
w2	Where is that water source located? *(CIRCLE ONLY **ONE** ANSWER)*	In own dwelling………………..………………...1 In own yard/plot………………………………2 Elsewhere……………………………….……3	If **1 or 2**, skip to **w4**
w3	How long does it take to go there, get water and come back? *(WRITE IN THE NUMBER.)* *(IF 'DON'T KNOW', RECORD 888)*	Minutes……………………… ☐☐☐	
w4	What do you **usually** do to the water to make it safer to drink? *(DO **NOT** PROMPT)* *(CIRCLE ONLY **ONE** ANSWER)*	Boil Add bleach / chlorine tablet Use a water filter Solar disinfection ………1 Strain it through a cloth Let it stand and settle Nothing Other ………2 Don't know…………………………….……....3	
w5	What kind of toilet facility do members of your household usually use? *(DO **NOT** PROMPT)* *(CIRCLE ONLY **ONE** ANSWER)*	Flush or pour flush toilet Ventilated improved pit (VIP) latrine Composting toilet Pit latrine with slab ………1 Pit latrine without slab Bucket Hanging latrine Bush or field No facilities ………2	
w6	Do you share this facility with other	Yes……………………………1 No…….………………………2	

	households? *(CIRCLE ONLY **ONE** ANSWER.)*		

SHORT BIRTH HISTORY			
N°	QUESTIONS	ANSWERS	SKIPS
bh1	Altogether, how many live births have you had in the last 5 years? Please include any baby who cried or showed other signs of life. *(WRITE IN THE NUMBER)* *(IF 'NONE', RECORD 00.* *IF 'DON'T KNOW', RECORD 88)*	☐☐	If **00** or **88**, skip to **household hunger scale** module.
bh2	Is this child / are these children still alive? *(CIRCLE ONLY **ONE** ANSWER)*	All live..1 One or more has died in the past 5 years ......2 Don't know…………………………..88	

HOUSEHOLD HUNGER SCALE			
N°	QUESTIONS	ANSWERS	SKIPS
hh1	How many times in the last month was there ever no food to eat of any kind in your house because of lack of resources to get food? *(WRITE IN THE NUMBER)* *(IF 'NONE,' RECORD 00.)*	Number of times ☐☐	
hh2	How many times in the last month did you or any household member go to sleep at night hungry because there was not enough food? *(WRITE IN THE NUMBER)* *(IF 'NONE,' RECORD 00.)*	Number of times ☐☐	
hh3	How many times in the last month did you or any household member go a whole day and night without eating anything at all because there was not enough food? *(WRITE IN THE NUMBER)* *(IF 'NONE,' RECORD 00.)*	Number of times ☐☐	

CHILD FEEDING PRACTICES			
N°	QUESTIONS	ANSWERS	SKIPS
cf1	Is [NAME OF CHILD] currently breastfed? *(CIRCLE ONLY **<u>ONE</u>** ANSWER)*	Yes……….....................1 No………..…..………..2	If **2**, skip to **cf3**.
cf2	Does [NAME OF CHILD] take any food or drink other than breastmilk? *(CIRCLE ONLY **<u>ONE</u>** ANSWER)*	Yes……….....................1 No…...…………………..2	If **2**, skip to **dietary diversity** module.
cf3	In the last 24 hours, how many times was [NAME OF CHILD] fed? Include the number of times he/she was fed any type of food (mashed or pureed food or solid or semi-solid food) as a meal or snack. *(WRITE IN THE NUMBER)* *(IF 'NONE,' RECORD 00.)* *(IF 'DON'T KNOW', RECORD 88)*	Number of times ☐☐	

DIETARY DIVERSITY
<u>Since the time you woke up yesterday to when you woke up today</u>, did you and [NAME OF CHILD] have any of the following things to eat or drink? I am interested in whether you had the item I mention, even if it was combined with other foods. For example, if you ate a boursch made with potatoes, cabbage, carrots and other vegetables, you should reply yes to any food I ask about that was an ingredient in it. Please do not include any food used in a small amount for seasoning or condiments (like chilies, spices, herbs, or fish powder), I will ask you about those foods separately. *(READ **<u>ALL</u>** QUESTIONS. CIRCLE ONLY **<u>ONE</u>** ANSWER FOR EACH.)*

N°	ITEMS	A. Caregiver	B. Child
dd1	Plain water?		Yes………1 No……….2
dd2	Tinned or powdered milk? Tinned or powdered infant formula such as Nestle, Similac, Nutrilon, Maliutka, Frisolac, Lactogen, or any other milk (excluding breast milk)?		Yes………1 No……….2
dd3	Any bread, rice noodles, biscuits, or any other foods made from millet, sorghum, maize, rice, wheat, buckwheat or other grains?	Yes………1 No……….2	Yes………1 No……….2
dd4	Any potatoes or any other foods made from roots or tubers?	Yes………1 No……….2	Yes………1 No……….2
dd5	Any food made from vegetables or root crops with yellow or orange flesh such as carrots, pumpkin, or sweet potatoes?	Yes………1 No……….2	Yes………1 No……….2
dd6	Any food made from dark green leafy vegetables such as spinach, kale, lettuce, sorrel and other locally available dark green leafy vegetables?	Yes………1 No……….2	Yes………1 No……….2
dd7	Any other vegetables?	Yes………1 No……….2	Yes………1 No……….2
dd8	Any food made from fruits with yellow or orange flesh such as mango or papaya?	Yes………1 No……….2	Yes………1 No……….2
dd9	Any other fruits?	Yes………1 No……….2	Yes………1 No……….2
dd10	Any beef, horse, pork, lamb, goat, rabbit, wild game, chicken, turkey, duck, or other birds?	Yes………1 No……….2	Yes………1 No……….2
dd11	Any liver, kidney, heart, or other organ meats?	Yes………1 No……….2	Yes………1 No……….2
dd12	Any eggs?	Yes………1 No……….2	Yes………1 No……….2
dd13	Any fresh or dried fish or shellfish?	Yes………1 No……….2	Yes………1 No……….2
dd14	Any, locust bean, soya bean, or other foods made from beans, peas, lentils, or legumes?	Yes………1 No……….2	Yes………1 No……….2
dd15	Any groundnut, cashew, walnut, almond or other foods made from nuts?	Yes………1 No……….2	Yes………1 No……….2

dd16	Any cheese, yogurt, milk or other milk products?	Yes………1 No……….2	Yes………1 No……….2
dd17	Any foods made with oil, fat, margarine or butter?	Yes………1 No……….2	Yes………1 No……….2
dd18	Any sugar or honey?	Yes………1 No……….2	Yes………1 No……….2
dd19	Any other foods, such as condiments, coffee, tea?	Yes………1 No……….2	Yes………1 No……….2

SALT IODIZATION COVERAGE			
N°	QUESTIONS	ANSWERS	SKIPS
si1	Now, I would like to talk with you about salt. Does your household use salt? *(CIRCLE ONLY **<u>ONE</u>** ANSWER)*	Yes………….……………………...1 No...........………………………..……2	If **2**, skip to **wheat flour** module.
si2	The **<u>last time</u>** your household got salt, where did you get it from? *(CIRCLE ONLY **<u>ONE</u>** ANSWER)*	Purchased………………..................1 Made it at home..............................2 Received from food aid...................3 Don't know / Don't remember.........88 Other: ____________________......99	If **2,** skip to **wheat flour** module.
si3	The **<u>last time</u>** your household got salt, how was it packaged? *(READ **<u>ALL</u>** RESPONSES)* *(CIRCLE ONLY **<u>ONE</u>** ANSWER)*	Original package…………………....1 Re-packaged………………………...2 My own container...........................3 Don't know ....88 Other: ____________________.....99	
si4	The **<u>last time</u>** your household got salt, what was the brand? *(CIRCLE ONLY **<u>ONE</u>** ANSWER)*	Araltuz ....1 Pavlodarsol....................................2 Suzaktuz...3 Indersol..4 Don't know ....88 Other: ____________________......99	
si5	The **<u>last time</u>** your household got salt, how much did you get? *(A. WRITE IN THE NUMBER)* *(B. CIRCLE THE UNIT)*	A. Quantity ☐☐☐☐ B. Kg..1 g ……………………………….…2	
si6	How long does this amount usually last in your household? *(A. WRITE IN THE NUMBER)* *(B. CIRCLE THE UNIT)*	A. Duration ☐☐ B. Day(s)...1 Month(s)..2	
si7	Do you have this salt in your home now? *(CIRCLE ONLY **<u>ONE</u>** ANSWER)*	Yes….……………………………...1 No…………………………………..……2	If **2**, skip to **wheat flour** module.

si8	May I take a small sample to test for iodine? *(CIRCLE ONLY **ONE** ANSWER)*	Sample taken……………………1 No sample taken…………………2	If **2**, skip to **si12**.
si9	***CONDUCT IODINE SPOT TEST AND RECORD RESULT***	Positive – Color change……………1 Negative - No color change………2	If **2**, skip to **si12**.
si10	May I take another small sample? *(IF 'YES', TAKE SAMPLE AND WRITE SAMPLE ID NUMBER ON BAG AS SHOWN IN si10)*	Sample taken……………………1 No sample taken……………..…2	If **2**, skip to **si12**.
si11	***RECORD SALT SAMPLE ID NUMBER***	☐☐ ☐☐ ☐☐ Oblast ID Cluster ID HH ID	
si12	***LOOK FOR FORTIFICATION LOGO OR WORDS SUCH AS IODIZED OR FORTIFIED*** *(CIRCLE ONLY **ONE** ANSWER)*	**Original package:** Logo or words observed.................1 Logo or words NOT observed……..2 **Not in original package:** Logo or words NOT observed…….3	

WHEAT FLOUR FORTIFICATION COVERAGE			
N°	QUESTIONS	ANSWERS	SKIPS
wf1	Now, I would like to talk with you about wheat flour. Does your household prepare foods using wheat flour (such as bread or other wheat flour products)? *(CIRCLE ONLY **ONE** ANSWER)*	Yes.......................................1 No...2	If **2**, skip to **bread** module.
wf2	The **last time** your household got wheat flour, what type of wheat flour did you get? *(CIRCLE ONLY **ONE** ANSWER)*	White / Premium or first grade flour...1 Brown / Second grade flour............2 Don't know / Don't remember.......88 Other: ____________________....99	If **2,** skip to **bread** module.
wf3	The **last time** your household got wheat flour, where did you get it from? *(CIRCLE ONLY **ONE** ANSWER)*	Purchased.................................1 Made it at home...........................2 Received from food aid................3 Don't know / Don't remember.....88 Other: ____________________..99	If **2,** skip to **bread** module.
wf4	The **last time** your household got wheat flour, how was it packaged? *(READ **ALL** RESPONSES)* *(CIRCLE ONLY **ONE** ANSWER)*	Original package.........................1 Re-packaged................................2 My own container........................3 Don't know ....88 Other: ____________________...99	
wf5	The **last time** your household got wheat flour, what was the brand? *(CIRCLE ONLY **ONE** ANSWER)*	Tsesna...1 Salem (Tsesna)...........................2 Korona (Kostanay)......................3 Zhelaevsky...................................4 Novo Alzhansky............................5 Ivolga..6 100 pudov....................................7 Altyn Dan ....8 Dani Nan ....9 Sultan ....10 Imperator ....11 Mutlu ....12 Ramazan ....13 Don't know ....88 Other: ____________________....99	
wf6	The **last time** your household got wheat flour, how much did you get? *(A. WRITE IN THE NUMBER)* *(B. CIRCLE THE UNIT)*	A. Quantity ☐☐☐☐ B. Kg..1 g..2	

wf7	How long does this amount usually last in your household? *(A. WRITE IN THE NUMBER.)* *(B. CIRCLE THE UNIT)*	A. Duration ☐☐ B. Day(s)...1 Month(s).......................................2	
wf8	Do you have this wheat flour in your home now? *(CIRCLE ONLY **ONE** ANSWER)*	Yes………..……………………...1 No…………………………..……2	If **2**, skip to **bread** module.
wf9	May I take a small sample to test for iron? *(CIRCLE ONLY **ONE** ANSWER)*	Sample taken…………………..1 No sample taken………..……...2	If **2**, skip to **wf13.**
wf10	***CONDUCT IRON SPOT TEST AND RECORD RESULT***	Positive - Red spots present………1 Negative - No red spots present….2	If **2**, skip to **wf13.**
wf11	May I take another small sample? *(IF 'YES', TAKE SAMPLE AND WRITE SAMPLE ID NUMBER ON BAG AS SHOWN IN wf12)*	Sample taken…………………1 No sample taken………..……2	If **2**, skip to **wf13.**
wf12	***RECORD WHEAT SAMPLE ID NUMBER***	☐☐ ☐☐ ☐☐ Oblast ID Cluster ID HH ID	
wf13	***LOOK FOR FORTIFICATION LOGO OR WORDS SUCH AS FORTIFIED OR ENRICHED WITH VITAMINS OR MINERALS*** *(CIRCLE ONLY **ONE** ANSWER)*	**Original package:** Logo or words observed...............1 Logo or words NOT observed…….2 **Not in original package:** Logo or words NOT observed……3	

BREAD FORTIFICATION COVERAGE			
N°	QUESTIONS	ANSWERS	SKIPS
br1	Now, I would like to talk with you about bread. Does your household eat bread at home? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes…..……………………………….1 No………..……………………..……2	If **2**, skip to **individual wheat flour** module.
br2	The **last time** your household ate bread, what type of bread did you eat? *(CIRCLE ONLY **ONE** ANSWER.)*	White bread ……………………..1 Black / Rye bread..………………2 Brown bread ……………………..3 Bran bread..………………………4 Don't know / Don't remember.....88 Other: ____________________...99	If **2, 3, or 4,** skip to **individual wheat flour** module.
br3	The **last time** your household ate bread, where did you get it from? *(CIRCLE ONLY **ONE** ANSWER)*	Purchased……………………..........1 Made it at home............................2 Received from food aid.................3 Don't know / Don't remember…...88 Other: ___________________......99	If **2**, skip to **individual wheat flour** module.
br4	The **last time** your household got bread, who was the producer? *(CIRCLE ONLY **ONE** ANSWER)*	Factory...1 Minibakery.....................................2 Don't know ....88 Other: ____________________.....99	
br5	Do you have this bread in your home now? *(CIRCLE ONLY **ONE** ANSWER)*	Yes…….………………………….1 No……………………………..……2	If **2**, skip to **individual wheat flour** module.
br6	May I take a small sample to test for iron? *(CIRCLE ONLY ONE ANSWER)*	Sample taken……………………1 No sample taken……….……….2	If **2**, skip to **individual wheat flour** module.
br7	***CONDUCT IRON SPOT TEST AND RECORD RESULT***	Positive - Red spots present……1 Negative - No red spots present…2	

INDIVIDUAL WHEAT FLOUR CONSUMPTION					
Now I would like to ask about how often and how much you and [NAME OF CHILD] consume specific foods made from wheat flour. 1. **In the last 7 days**, how many times did you and [NAME OF CHILD] eat [FOOD ITEM]? *(REPEAT QUESTION FOR EACH FOOD ITEM LISTED BELOW)* 2. Usually how much of [FOOD ITEM] did you and [NAME OF CHILD] eat at one sitting? *(SHOW PICTURES OF PORTIONS AND REPEAT QUESTION FOR EACH FOOD ITEM LISTED BELOW. IF FREQUENCY = 00, DO NOT ASK PORTION SIZE, JUST RECORD '0' FOR PORTION SIZE.)*					
N°	ITEMS	A. Caregiver		B. Child	
		1. Frequency (# times)	2. Portion size	1. Frequency (# times)	2. Portion size
wfc1	Sliced white bread				
wfc2	Sliced baton rifled				
wfc3	Buns, pljushki				
wfc4	Lavash, pita bread				
wfc5	Pizza				
wfc6	Regular layer cake				
wfc7	Sausage roll				
wfc8	Beef burger with egg				
wfc9	Chickenpie				
wfc10	Round donut/croissant				
wfc11	Shelpek				
wfc12	Tortillas				
wfc13	Chebureks				
wfc14	Samsa				
wfc15	Pies				
wfc16	Belyashi				
wfc17	Baursaks				
wfc18	Pancakes				
wfc19	Fritters				

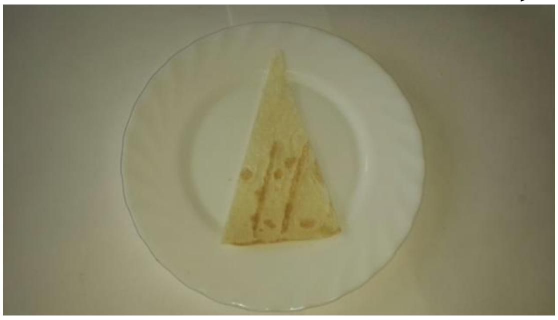
wfc20	Doughnut ring				
wfc21	Manty				
wfc22	Pelmeni (dumplings)				
wfc23	Vareniki (pierogi)				
wfc24	Oram (roll)				
wfc25	Beshbarmak				
wfc26	Laghman				
wfc27	Noodles home				
wfc28	Regular cake				
wfc29	Burger				
wfc30	Meat pie				
wfc31	Shred-pie				
wfc32	Cookie				
wfc33	Sliced baguette rifled				

FORTIFICATION LOGO KNOWLEDGE AND INFLUENCE			
N°	QUESTIONS	ANSWERS	SKIPS
lk1	*(SHOW KAZAKHSTAN FORTIFICATION LOGO)* Have you ever seen this? *(CIRCLE ONLY **ONE** ANSWER)*	Yes……………………………………….1 No……………………………………….2	If **2**, skip to **health and nutrition** module.
lk2	What does this logo mean? *(**DO NOT READ** RESPONSES TO RESPONDENT)* *(CIRCLE **ALL** RESPONSES THAT APPLY)*	Fortified / enriched / added micronutrients .1 Good for health……………….……………..2 Better quality ………………………………..3 Bad quality………………………………….4 More expensive…………………………....5 No meaning ………………………………..6 Don't know………………………………...88 Other: ___________________________...99	
lk3	Does this logo influence your decision to buy food products? *(**DO NOT READ** RESPONSES TO RESPONDENT.)* *(CIRCLE ONLY **ONE** ANSWER.)*	No, it does not influence my decision to buy products……………………………………....1 Yes, it motivates me to buy products..........2 Yes, it discourages me to buy products......3 Don't know..88 Other: ___________________________.....99	

HEALTH AND NUTRITION DATA			
N°	QUESTIONS	ANSWERS	SKIPS
MOTHER / CAREGIVER			
muacm	Now I would like to check you and [NAME OF CHILD]'s nutritional status. May I measure your arm circumference? *TAKE THE MUAC OF THE **MOTHER / CAREGIVER** ON HER LEFT ARM* *IF 'REFUSED,' RECORD 666.* *IF ARM IS TOO BIG, RECORD 777.* *IF THE RESPONDENT IS A MAN, RECORD 555.*	mm ☐☐☐	*If MUAC **< 185mm*** ***→ Refer!***
CHILD			
muacc	May I measure [NAME OF CHILD]'s arm circumference? *TAKE THE MUAC OF THE **CHILD** ON HIS / HER LEFT ARM* *IF 'REFUSED,' RECORD 666.* *IF CHILD IS NOT AVAILABLE, 'RECORD 777.*	mm ☐☐☐	*If <6 months and MUAC **< 110 mm*** *OR* *>6 months and MUAC **< 115 mm*** ***→ Refer!***

LAVASH, PITA BREAD

1



0,125 of lavash

2

0,25 of lavash

3

0,5 of lavash

4

0,75 of lavash

5

1 of lavash

6

1,5 of lavash

7

2 lavashs

3: RESULTS FROM HOUSEHOLD COVERAGE FIGURES 2 AND 3 IN TABLE FORMAT

Table 7: Household coverage of salt, wheat flour and wheat flour bread, Kazakhstan, 2016[1,2]

Variable	Percent (95% CI) National N=2004	Urban N=1002	Rural N=1002	P-value†
Salt				
Household consumes[2] salt	99.9 (99.8, 100.0)	99.9 (99.7-100.0)	100	0.319
Household consumes fortifiable[3] salt	99.9 (99.8, 100.0)	99.9 (99.7, 100.0)	100	0.319
Household consumes fortified[4] salt	88.4 (87.0, 89.8)	91.1 (89.3, 92.9)	84.9 (82.7, 87.1)	0.000
Household consumes salt fortified within standard[5]	80.5 (78.7, 82.2)	82.5 (80.1, 84.8)	77.8 (75.3, 80.4)	0.009
Wheat flour				
Household consumes wheat flour	99.5 (99.2, 99.8)	99.2 (98.7, 99.8)	99.9 (99.7, 100.0)	0.024
Household consumes fortifiable wheat flour	99.4 (99.1, 99.7)	99.1 (98.6, 99.7)	99.8 (99.5, 100.0)	0.055
Household consumes fortified wheat flour	40.7 (38.6, 42.9)	46.7 (43.6, 49.8)	33.0 (30.0, 35.9)	0.000
Household consumes fortified wheat flour wihtin standard	25.1 (23.2, 27.0)	31.8 (28.9, 34.7)	16.4 (14.1, 18.6)	0.000
Bread				
Household consumes wheat bread	99.8 (99.7, 100.0)	99.7 (99.4, 100.0)	100	0.097
Household consumes fortifiable wheat bread	55.1 (53.0, 57.3)	64.6 (61.6, 67.5)	42.8 (39.8, 45.9)	0.000
Household consumes fortified wheat bread	3.1 (2.3, 3.8)	3.0 (1.9, 4.0)	3.2 (2.1, 4.3)	0.795

Abbreviations: CI, confidence interval

[1] All values are percent as indicated and are weighted to correct for unequal probability of selection.

[2] "Consumes" refers to households that reported using this food at home.

[3] "Consumes fortifiable" refers to households that reported consuming a food vehicle that was not made at home and is assumed to be industrially processed (for wheat flour this refers only to white/premium or first grade flours; for bread this refers to any bread made from white/premium or first grade wheat flour).

[4] "Consumes fortified" refers to households that consumed a food that was confirmed to be fortified by spot test or quantitative laboratory analyses.

[5] "Consumes fortified within standard" refers to households that consumed a food that was confirmed to be fortified according to national standards by quantitative laboratory analyses (i.e. 45-65 ppm of total iron for wheat flour and 25-65 ppm iodine for salt).

† P-value calculated using the independent samples t-test, adjusted for unequal probability of selection.

4: SUPPLEMENTARY TABLES OF RESULTS ON FORTIFICATION LEVELS OF FOOD SPECIMENS

Table 8: Fortification quality of household salt and wheat flour samples compared to national standards stratified by oblast, Kazakhstan, 2016

Oblast	**N**	**Mean**			
		Unfortified	**Fortified below standard**	**Fortified within standard**	**Fortified above standard**
Salt[1]					
Kostanay	124	0.0	0.0	100.0	0.0
Mangystau	51	0.0	0.0	100.0	0.0
East Kazakhstan	176	0.6	17.6	81.2	0.6
Almaty Oblast	226	2.5	16.2	81.4	0.0
Almaty City	169	2.4	4.2	93.4	0.0
Astana City	87	2.7	11.8	85.5	0.0
Pavlodar	79	3.7	0.0	96.3	0.0
Kzylorda	72	3.9	0.0	96.1	0.0
Karaganda	156	4.5	16.5	79.0	0.0
North Kazakhstan	51	8.6	1.9	87.5	1.9
Akmola	98	9.5	0.0	90.5	0.0
Aktobe	101	12.2	1.0	86.8	0.0
Zhambyl	123	18.9	14.4	66.8	0.0
South Kazakhstan	339	30.0	8.0	61.9	0.0
Atyrau	51	32.9	0.0	67.1	0.0
West Kazakhstan	101	37.2	0.0	62.8	0.0
All, N or mean	**2004**	**10.6**	**5.7**	**83.5**	**0.16**
Wheat flour[2]					
Kostanay	123	12.7	80.1	7.2	0.0
Mangystau	101	15.1	6.9	78.0	0.0
East Kazakhstan	100	27.6	17.9	54.5	0.0
Almaty Oblast	166	42.6	4.6	52.9	0.0
Almaty City	83	43.6	5.5	50.9	0.0
Astana City	98	44.7	33.0	22.3	0.0
Pavlodar	51	56.1	6.6	37.3	0.0
Kzylorda	72	61.9	21.6	16.5	0.0
Karaganda	226	63.8	6.6	29.6	0.0
North Kazakhstan	51	68.7	22.7	8.6	0.0
Akmola	51	71.7	6.0	22.3	0.0
Aktobe	123	72.8	10.9	16.3	0.0
Zhambyl	339	76.9	11.0	12.1	0.0
South Kazakhstan	174	77.4	12.4	10.2	0.0
Atyrau	79	79.5	12.2	8.3	0.0
West Kazakhstan	156	84.0	9.4	6.6	0.0
All, N or mean	**1993**	**56.2**	**16.7**	**27.1**	**0.0**

[1] For iodine in salt: "unfortified" <0 ppm, "fortified below standard" <25 ppm, "fortified within standard" 25-55 ppm, and "fortified above standard" >55 ppm.

[2] For total iron in wheat flour: "unfortified" <9.7 ppm (estimate of intrinsic iron from laboratory analyses of unfortified samples), "fortified below standard" 9.7-44.9 ppm, "fortified within standard" 45-65 ppm, and "fortified above standard" >65 ppm.

Table 9: Comparative results of spot test and quantitative laboratory analyses of household salt samples by brand, Kazakhstan, 2016

Brand	N	Iodine spot test results[1]		Mean iodine level in positive samples, ppm[2]	Mean iodine level in all samples, ppm[3]
		Positive (n)	Negative (n)		
Araltuz	1290	1271	19	43.87	43.22
Sol Iletskaia	252	202	50	44.45	35.63
Composite	56	6	50	41.41	4.44
Barskie produkty	43	43	0	41.86	41.86
As tuzy	40	24	16	31.70	19.02
Ekstra	25	23	2	45.62	41.97
Sol/Tuz	19	3	16	42.28	6.68
Ak tuz	16	3	13	14.79	2.77
Iodirovannaia sol	8	3	5	46.50	17.44
Slavianka	6	2	4	42.28	14.09
Asyl tuz	4	1	3	17.96	4.49
Morskaya	4	1	3	45.45	11.36
Pavlodarsol	2	2	0	130.01	130.01
Nuraidar	1	1	0	39.10	39.10
Obshestvo	1	1	0	42.28	42.28
Unknown	206	155	51	15.85	11.93
All	**1973**	**1741**	**232**	**42.84**	**29.14**

[1] Salt samples collected in the households were assayed in the field for their content of iodine by using of "Improved Iodised Salt Field Test Kit for salt fortified with potassium iodate only" (MBI Kits International, Chennai, India). If the test of salt for iodine is positive, then this means that the salt is iodized.

[2] Quantitative iodine content of iodated salt samples is measured using an iodometric titration (DeMaeyer E. M., Lowenstein F. W., Thilly C. H. 1979).

[3] Negative samples are assigned zero when calculating the mean iodine level of all samples from a brand.

Table 10: Comparative results of spot test and quantitative laboratory analyses of household wheat flour samples by brand, Kazakhstan, 2016

No.	Brand	N	Iron spot test results[1]		Mean total iron level in positive samples, ppm[2]	Mean added iron level in positive samples ppm[3]	Mean added iron level in all samples, ppm[4]
			Positive (n)	Negative (n)			
1	Tsesna	228	193	35	51,7	42,0	35,6
2	Altyn Dan	118	73	45	45,9	36,2	22,4
3	Korona (Kostanay)	90	76	14	39,0	29,3	24,8
4	Dani Nan	84	3	81	64,5	54,8	2,0
5	Damir	71	7	64	25,9	16,2	1,6
6	100 pudov	66	3	63	19,6	9,9	0,4
7	Zhaksy	61	5	56	21,9	12,2	1,0
8	Snezhinka	59	1	58	52,5	42,8	0,7
9	Zhelaevsky	56	50	6	49,8	40,1	35,8
10	Granum	44	43	1	45,9	36,2	35,4
11	Elit	41	1	40	33,1	23,4	0,6
12	Pioner	39	10	29	57,8	48,1	12,3
13	Beles	34	27	7	55,7	46,0	36,5
14	Yntymak	34	10	24	16,5	6,8	2,0
15	Beyneu	27	0	27	32,6	22,9	0,0
16	Patsha	27	3	24	34,4	24,7	2,7
17	Dobroye	26	9	17	46,4	36,7	12,7
18	Ak-Nan	24	1	23	36,8	27,1	1,1
19	Banu	21	20	1	43,5	33,8	32,1
20	Sultan	20	17	3	44,6	34,9	29,7
21	Imperator	19	6	13	41,7	32,0	10,1
22	Bereket	17	0	17	32,6	22,9	0,0
23	Grand	15	0	15	32,6	22,9	0,0
24	Atbasar	15	1	14	36,8	27,1	1,8
25	Altyn Astyk	15	1	14	29,4	19,7	1,3
26	Salem (Tsesna)	14	13	1	55,0	45,3	42,1
27	Ramazan	14	0	14	32,6	22,9	0,0
28	Farman	14	0	14	32,6	22,9	0,0
29	Darad	14	0	14	32,6	22,9	0,0
30	Aisara	14	1	13	39,5	29,8	2,1
31	Vahtet	14	0	14	32,6	22,9	0,0
32	Akniet	13	2	11	55,3	45,6	7,0
33	Berkat	12	0	12	32,6	22,9	0,0
34	Mulen	11	3	8	22,4	12,7	3,5
35	Askom	11	0	11	32,6	22,9	0,0
36	Keremet	10	5	5	28,6	18,9	9,4
37	Maizot	9	9	0	18,6	8,9	8,9
38	Otyrar 777	9	1	8	32,6	22,9	2,5
39	Tamerlan	9	1	8	20,0	10,3	1,1
40	Grain House	8	6	2	18,1	8,4	6,3

41	555 Ekstra	8	1	7	32,6	22,9	2,9
42	Dostyk	8	1	7	32,6	22,9	2,9
43	El Orda	8	0	8	32,6	22,9	0,0
44	Mutlu	7	1	6	32,6	22,9	3,3
45	Ordabasy	7	0	7	32,6	22,9	0,0
46	Sej-nar	7	0	7	32,6	22,9	0,0
47	Atameken	7	0	7	32,6	22,9	0,0
48	Pakhomovskaya	6	6	0	30,1	20,4	20,4
49	Uno	6	5	1	20,3	10,6	8,8
50	Romana	6	6	0	33,2	23,5	23,5
51	Akbidaj	6	2	4	15,3	5,6	1,9
52	Tandyr	6	0	6	32,6	22,9	0,0
53	Agrokom	5	0	5	32,6	22,9	0,0
54	Beloshezhka	5	0	5	32,6	22,9	0,0
55	Torgai	5	0	5	32,6	22,9	0,0
56	Petropavlovsk	5	0	5	38,4	28,7	0,0
57	Staraya Melnica	5	0	5	32,6	22,9	0,0
58	AK-Elit "Bolashak"	5	0	5	32,6	22,9	0,0
59	Sana	5	1	4	32,6	22,9	4,6
60	Muka	5	1	4	32,6	22,9	4,6
61	Snezhnaya Koroleva	4	0	4	32,6	22,9	0,0
62	Karagandinskaya	4	0	4	32,6	22,9	0,0
63	Biday Muka	4	1	3	32,6	22,9	5,7
64	Altyn Dala	4	3	1	22,8	13,1	9,8
65	Kostanay	4	0	4	32,6	22,9	0,0
66	Ardager	4	3	1	56,9	47,2	35,4
67	Alpamys	4	3	1	50,5	40,8	30,6
68	Tsar'	4	0	4	32,6	22,9	0,0
69	Chingishan	4	0	4	32,6	22,9	0,0
70	Aknar	4	1	3	32,6	22,9	5,7
71	Zhandos	3	0	3	52,2	42,5	0,0
72	Shymkent-Dan	3	0	3	32,6	22,9	0,0
73	Krasnyi Yar	3	0	3	32,6	22,9	0,0
74	Zheikhun	3	0	3	32,6	22,9	0,0
75	Ak-adil	3	2	1	28,9	19,2	12,8
76	Agro	3	0	3	32,6	22,9	0,0
77	Beibarys	3	2	1	29,7	20,0	13,3
78	Darat	3	0	3	32,6	22,9	0,0
79	Esil	3	0	3	32,6	22,9	0,0
80	Imperator	3	0	3	32,6	22,9	0,0
81	Ivolga	2	2	0	22,6	12,9	12,9
82	Ulanver	2	0	2	32,6	22,9	0,0
83	Mukatai	2	2	0	32,6	22,9	22,9
84	Aksarai	2	2	0	59,3	49,6	49,6
85	Baiterek	2	1	1	32,6	22,9	11,4
86	Beliaevskaja	2	0	2	32,6	22,9	0,0
87	Galabat	2	1	1	32,6	22,9	11,4
88	Dobrynia	2	0	2	32,6	22,9	0,0

89	Damdi nan	2	0	2	32,6	22,9	0,0
90	Dievskaja	2	0	2	32,6	22,9	0,0
91	Zhanbota	2	1	1	32,6	22,9	11,4
92	Majakum	2	1	1	32,6	22,9	11,4
93	MN	2	0	2	32,6	22,9	0,0
94	Merke	2	1	1	32,6	22,9	11,4
95	Miller	2	0	2	32,6	22,9	0,0
96	Midia	2	0	2	32,6	22,9	0,0
97	Saryarka	2	1	1	32,6	22,9	11,4
98	Samruk	2	0	2	32,6	22,9	0,0
99	Smei-Elita-2	2	0	2	32,6	22,9	0,0
100	Fajza	2	0	2	32,6	22,9	0,0
101	Jetalon	2	0	2	32,6	22,9	0,0
102	Astrahanskaia	2	0	2	32,6	22,9	0,0
103	Aina	2	0	2	32,6	22,9	0,0
104	Aktogan	2	0	2	32,6	22,9	0,0
105	Akmaral	2	1	1	28,9	19,2	9,6
106	Luganskoe	2	0	2	32,6	22,9	0,0
107	Tajinshinskiy	2	2	0	47,2	37,5	37,5
108	Akmola	2	1	1	32,6	22,9	11,4
109	Orion muka	2	1	1	32,6	22,9	11,4
110	Intertreit	2	0	2	32,6	22,9	0,0
111	Shamalgan	2	1	1	46,0	36,3	18,2
112	Dez	1	1	0	32,6	22,9	22,9
113	Zhasar	1	0	1	32,6	22,9	0,0
114	Gold spike	1	0	1	32,6	22,9	0,0
115	Makfa	1	0	1	32,6	22,9	0,0
116	Miller & K	1	0	1	32,6	22,9	0,0
117	Promana	1	0	1	32,6	22,9	0,0
118	Sana	1	0	1	32,6	22,9	0,0
119	Aigerim	1	0	1	32,6	22,9	0,0
120	Aist	1	0	1	32,6	22,9	0,0
121	Akbastau	1	1	0	32,6	22,9	22,9
122	Akkum astyk	1	0	1	32,6	22,9	0,0
123	Akpankos	1	0	1	32,6	22,9	0,0
124	Aksai	1	0	1	32,6	22,9	0,0
125	Aksuat	1	0	1	32,6	22,9	0,0
126	Alan	1	0	1	32,6	22,9	0,0
127	Aleumenttik un	1	0	1	32,6	22,9	0,0
128	Arai	1	0	1	32,6	22,9	0,0
129	Aruzhan	1	0	1	32,6	22,9	0,0
130	Asar	1	0	1	32,6	22,9	0,0
131	Astana	1	0	1	32,6	22,9	0,0
132	Astyk	1	0	1	32,6	22,9	0,0
133	Asyl arman	1	0	1	32,6	22,9	0,0
134	Atamura	1	0	1	32,6	22,9	0,0
135	Dana	1	0	1	32,6	22,9	0,0
136	Dilnaz	1	0	1	32,6	22,9	0,0
137	Zhan-Dos	1	1	0	32,6	22,9	22,9
138	Zhaskanat	1	0	1	32,6	22,9	0,0

139	Zahra	1	0	1	32,6	22,9	0,0
140	Ivloev	1	0	1	32,6	22,9	0,0
141	Kazakhstan	1	0	1	32,6	22,9	0,0
142	Kanuton	1	0	1	32,6	22,9	0,0
143	KMK	1	0	1	32,6	22,9	0,0
144	Koluton-95	1	0	1	32,6	22,9	0,0
145	Leila	1	1	0	32,8	23,1	23,1
146	Lider	1	0	1	32,6	22,9	0,0
147	Lima	1	0	1	32,6	22,9	0,0
148	Mak-mak	1	0	1	32,6	22,9	0,0
149	Maliutskiy	1	0	1	32,6	22,9	0,0
150	Merei	1	0	1	32,6	22,9	0,0
151	Olutan	1	0	1	32,6	22,9	0,0
152	Pavlodarskaia	1	0	1	32,6	22,9	0,0
153	Catti	1	0	1	32,6	22,9	0,0
154	Salem	1	0	1	32,6	22,9	0,0
155	Senmurzaev	1	0	1	32,6	22,9	0,0
156	Skazka	1	0	1	32,6	22,9	0,0
157	Tumar	1	0	1	32,6	22,9	0,0
158	Uvelka	1	0	1	32,6	22,9	0,0
159	Umka	1	1	0	39,7	30,0	30,0
160	Ushtobinskaia	1	1	0	48,5	38,8	38,8
161	Fiera	1	1	0	32,6	22,9	22,9
162	Horoshaia	1	0	1	32,6	22,9	0,0
163	Shanyrak	1	0	1	32,6	22,9	0,0
164	Shahris	1	0	1	32,6	22,9	0,0
165	Ekspert	1	1	0	32,6	22,9	22,9
166	Emir	1	0	1	32,6	22,9	0,0
167	Unknown	133	11	122	32,6	22,9	1,9
	TOTAL	**1869**	**677**	**1192**	**34,1**	**24,4**	**6,0**

[1] Spot test for iron in flour – is a qualitative method for iron (The USAID Micronutrient program, 2000). The method is applicable to iron testing in fortified flour and in bread crumbs of fortified flour. If the spot test of flour for iron is positive, then this means that the flour is fortified. This method, approved by American Association of Cereal Chemists (AACC), is applicable for only qualitative determinations of iron in fortified flour.

[2] For the quantitative determination of iron in flour samples used atomic absorption method (Interstate standard GOST 30178-96). Quantitative determination of iron content in flour samples was carried out by an accredited laboratory "Nutritest" using Atomic Absorption spectrometer Analyst 200, PerkinElmer.

[3] Adjusted for intrinsic iron in wheat flour, which is estimated to be 9.7 ppm from quantitative analyses of unfortified wheat flour samples.

[4] Negative samples are assigned zero when calculating the mean added iron level of all samples from a brand.

5: DESCRIPTION OF ANALYTICAL METHODS APPLIED TO FOOD SAMPLES

A. Qualitative spot test method for the determination of iodine in salt samples

Salt samples collected in the households were assayed in the field for their content of iodine (MBI Kits International 2016) by using of “Improved Iodized Salt Field Test Kit for salt fortified with potassium iodate only” (MBI Kits International, Chennai, India). Expiry data for the Test Kit was September 2016.

The Test Kit allows the determination of the presence of iodine in the salt.

First drop method for determining the iodine content in iodized salt was described in 1978 year [7]. Standard Test Kits to determine the presence of iodine on salt are based on this method.

The Test Kit contains the following:

Two Test Solution ampoules of 10 ml, one Recheck solution ampoule of 10 ml, one color chart, and one white cup.

User Instruction:

1) Fill small cup with salt, then spread the salt surface flat.
2) Add two drops of the test solution on the surface of the salt by piercing the white ampoule with a pin and gently squeezing the ampoule.
3) Compare the color on the salt with the color chart, within 1 minute and determine the iodine content.
4) If no color appears on the salt (after 1 minute), on a fresh sample add up to 5 drops of the recheck solution in red ampoule and then add 2 drops of test solution on the same spot. Now compare the color with the color chart and determine the iodine content.

Note:

1) Shake well before use.
2) This kit can be used for coarse salt also.
3) For precise results, an analytical check is recommended.
4) Shelf life is 18 months.
5) For reliable results, do not use an open ampoule beyond 180 days.
6) Not for oral consumption.
7) Store in dry cool place.

B. Quantitative method for the determination of iodine in salt samples

Quantitative iodine content of iodated salt samples is measured using an iodometric titration (DeMaeyer, Lowenstein, and Thilly, 1979), in the reference laboratory of the Kazakh Academy of Nutrition. The method is based on the determination of the iodine liberated by reacting potassium iodate and potassium iodide in an acidic medium, with a solution of sodium thiosulfate in the presence indicator. Indicator - starch. The mechanism of the two-step reaction may be represented as follows:

$$\underset{\text{(from salt)}}{KJO_3} + \underset{\text{potassium iodide}}{5KJ} + 3H_2SO_4 = 3J_2 + 3K_2SO_4 + 3H_2O \quad (1)$$

$$2Na_2S_2O_3 + J_2 = 2NaJ + Na_2S_4O_6 \quad (2)$$

Step 1: The liberation of free iodine (I_2) from iodized salt. Adding sulfuric acid (H_2SO_4) causes the liberation from potassium iodate (KIO_3) in the composition of the iodized salt sample.

Step 2. Titration of free iodine (I_2) by sodium thiosulfate (Na2S2O3). In the titration stage free iodine is absorbed, the amount of spent thiosulfate is proportional to the amount of the released iodine from salt. Addition of starch as an external (indirect) indicator of this reaction followed by reacting it with iodine and as a result, the appearance of a blue color. Starch is added at the end, when there are only traces of free iodine. The disappearance of the blue color with a further addition of sodium thiosulfate – is the final point of the analysis, in which the amount spent sodium thiosulfate is fixed and recorded.

Characteristics of reagents used for determination of iodine in iodized salt:

1) Deionized water, obtained by equipment for desalination - type R 200
2) Sulfuric Acid 40% (analytical grade), made in Germany, catalog number 09286.2500
3) Potassium iodide (analytical grade), made in Germany, catalog number 05044.0050
4) Sodium chloride (analytical grade), made in Germany, catalog number 06404.0500
5) Sodium thiosulfate (analytical grade), made in France, catalog number A 4380041
6) Starch soluble purified, made in France, catalog number A 4725308

This method is incorporated in the State standard of RK "Edible iodized salt". Methods for determination of iodine and sodium thiosulfate ST RK GOST R 51575 - 2003.

C. Qualitative spot test method for determination of iron content in flour and bread

This method (The USAID Micronutrient program, 2000), approved by American Association of Cereal Chemists (AACC), is applicable for only qualitative determinations of iron in fortified flour.

Spot test of wheat flour on the iron content is carried out in order to determine whether the flour is fortified, as premix for fortification of wheat flour used in Kazakhstan, contains iron. If the spot test of flour for iron is positive, then this means that the flour is fortified.

Spot test for iron in flour – is a qualitative method for iron. The method is applicable to iron testing in fortified flour and in bread crumbs of fortified flour.

Principle

Ferric iron added to flour reacts with a thiocyanate (KSCN) reagent to form a red colored complex. A higher number of red spots and a deeper red color appear with enriched and fortified flour compared with untreated flour.

Advantages

1) It is a simple, fast, and easy technique requiring no sample pretreatment.
2) It is inexpensive; only two reagents, KSCN and HCl, are needed.
3) Personnel with minimal training can conduct this assay.
4) It does not require a laboratory; it can be conducted in the flour mill, and in household level.

Limitations

It is not quantitative, i.e., it does not determine the amount of iron present in the sample. It can not be used in case of NaFeEDTA. A special test has been developed by NaFeEDTA manufacturers.

Important Note

This method shows only ferric iron. If iron is added in the ferrous form, the sample needs to be oxidized with hydrogen peroxide to convert the ferrous to ferric iron before analysis.

Materials Required

- Flour and Fortified flour: standard flour and flour to be tested should be of approximately the same moisture content
- Rectangular glass or rigid galvanized iron plate, about 12 x 8 cm
- Flour trier (spatula)
- Fortifcant (premix)
- Reagents – KSCN : HCL : Hydrogen peroxide

Reagents Preparation

- Thiocyanate reagent - Dissolve 10 g KSCN in 100 ml water.
- HCL reagent: Prepare 2N HCl - To a 500 ml beaker, add 100 ml distilled water. Then pour slowly 17 ml of concentrated HCl, and finally 83 mL more of water.
- Hydrogen peroxide: Prepare 3% (only when iron is as elemental iron or as a ferrous salt). Add 5 ml concentrated H_2O_2 (30%) to 45 ml distilled water. Prepare daily.
- Discard after finishing the analysis

Reagents 1 and 2

- Reagent 1: mix 10 mL of KSCN (potassium thiocyanate) solution with 10 mL of HCl-2N.

▪ Reagent 2: 3% Hydrogen peroxide

Procedure for Determination of ferrous iron

Slick untreated and enriched flour side by side in usual manner i. e , Place approximately 10-15 g flour on glass or iron plate. Pack one side in straight line by means of flour slick. Treat same quantity of standard flour used by comparison in same manner, so that straight edges of two flours are adjacent.

Drop approximately 1 ml thiocyanate reagent at junction of the two flours, in amount sufficient to wet area approximately 1 inch in diameter.

Drop approximately 1 ml of 3% hydrogen peroxide over same area wet by thiocyanate reagent

Let stand at least 10 min. If added ferric compounds are present, deeper red color will be formed than in untreated flour. Small Procedure for Determination of ferrous iron local areas of intense red show up after 20 min, indicating location of individual particles of iron compound. (This affords some estimation of uniformity of mixing.)

The ferrous iron will have been oxidized to the ferric state by the hydrogen peroxide.

If there are iron components added to the flour, they will appear as red spots on the surface. When the iron content is low, the latter is detected in the form of small dots, for the appearance of which time is required. Iron sulphate is found in the form of spots of a larger size, which appear more quickly. The density of the spots makes it possible to assess the amount of iron added. The spots are all the more pronounced, the more iron is added to the flour.

According to the number and severity of spots can also judge the level of iron in flour (semi-quantitative method). Figure 1 shows an example of iron spots in flour samples with various levels of added iron.

No added iron **Iron, 30 ppm** **Iron, 50 ppm**

Figure 1 – Semi-quantitative method for determination of iron in flour by spot test.

D. Quantitative method for determination of iron content in flour

For the quantitative determination of iron in flour samples used atomic absorption method (Interstate standard GOST 30178-96). This standard is largely in agreement with the AACC 40-70 method (AOAC International. 1995) (final approval on October 16, 1991; repeated assertion November 3, 1999). Quantitative determination of iron content in flour samples was carried out by an accredited laboratory "Nutritest" using Atomic Absorption spectrometer Analyst 200, PerkinElmer.

Informal translation

GOST 30178-96

INTERSTATE STANDARD

RAW MATERIAL AND FOODSTUFFS

Atomic Absorption Method for Toxic Elements Determination

Official Publication

Moscow
Standardinform
2010

Introduction

1 DEVELOPED by Institute of Nutrition of the Russian Academy of Medical Sciences
INTRODUCED by the State Standard of Russia

2 ACCEPTED by the Interstate Council for Standardization, Metrology and Certification (Minutes No 10 dated October 4, 1996)

Voted for the adoption:

State Title	Name Of The National Standardization Body
Republic of Azerbaijan	Azgosstandard
Republic of Armenia	Armgosstandard
Republic of Belarus	State Standard of Belarus
Republic of Kazakhstan	State Standard of the Republic of Kazakhstan
Kyrgyz Republic	State Standard of the Republic of Kazakhstan
Republic of Moldova	Standard of Moldova
Russian Federation	State Standard of Russia
Republic of Tajikistan	Tajik State Center for Standardization, Metrology and Certification
Turkmenistan	Turkmen Main State Inspection
Ukraine	State Standard of Ukraine

3 FIRST INTRODUCED

4 By the Resolution of the Russian Federation State Committee for Standardization, Metrology and Certification of March 26, 1997 No. 112 the Interstate Standard GOST 30178-96 was directly put into effect as the Russian Federation State Standard from January 1, 1998

5 REVISED. March 2010.

INTERSTATE STANDARD

RAW MATERIAL AND FOODSTUFFS

Atomic Absorption Method for Toxic Elements Determination

Raw Material and Foodstuffs

Atomic Absorption Method for Toxic Elements Determination

Effective Date: 1998-01-01

1 Application Range

This standard is applied to raw materials and foodstuffs, and specifies the method for determination of lead, cadmium, copper, zinc and iron.

The method is based on the product mineralization by dry or wet ashing and determination of element concentration in the mineralizer solution by flame atomic absorption.

2 Normative References

This standard uses references to the following standards:

GOST 1770—74 Measure Laboratory Glassware. Cylinders, Beakers, Flasks, Test Tubes. General Specifications

GOST 3652—69 Reagents. Monohydrate and Anhydrous Citric Acid. Specifications

GOST 3760-79 Reagents. Ammonium Hydroxide. Specifications

GOST 4165-78 Reagents. Copper (II) Sulfate 5-Aqueous. Specifications

GOST 4208-72 Reagents. Salt of the Oxide of Iron and Ammonium Double Sulfate (Mohr's Salt).

Specifications

GOST 4212-76 Reagents. Preparation of Solutions for the Colorimetric Nephelometric Analysis

GOST 4236-77 Reagents. Lead (II) Nitrate. Specifications

GOST 5457-75 Dissolved and Gaseous Technical Acetylene. Specifications

GOST 6709-72 Distilled Water. Specifications

GOST 8864-71 Reagents. Sodium N, N- diethyldithiocarbamate, 3-Aqueous. Specifications

GOST 10262—73 Reagents. Zinc Oxide. Specifications

GOST 11125-84 Nitric Acid of High Purity. Specifications

GOST 14261-77 Hydrochloric Acid of High Purity. Specifications

GOST 22300-76 Reagents. Ethyl and Butyl Esters of Acetic Acid. Specifications

GOST 24104-88* Laboratory Balance of General Purpose and Exemplary. General Specifications

GOST 25336-82 Laboratory Glassware and Equipment Made of Glass. Types, Basic Parameters and Dimensions

GOST 26929-94 Raw Materials and Foodstuffs. Sample Preparation. Mineralization for Determination of the Content of Toxic Elements

GOST 26931—86 Raw Materials and Foodstuffs. Methods for Copper Determination

GOST 26932-86 Raw Materials and Foodstuffs. Methods for Lead Determination

GOST 26933-86 Raw Materials and Foodstuffs. Methods for Cadmium Determination

GOST 26934-84 Raw Materials and Foodstuffs. Methods for Zinc Determination

____

*From July 1, 2002, GOST 24104-2001 will be effective (on the territory of the Russian Federation, GOST 53228-2008 is effective)

Official publication

GOST 29169-91 (ISO 648-77) Laboratory Glassware. One-Mark Pipettes
GOST 29251-91 (ISO 385-1-84) Laboratory Glassware. Burettes. Part 1: General Requirements
TS 6—09—1240—76 Isoamyl Acetate (Izopentilasetat). Specifications
TS 6—09—1678—86 Ashless Filter. Specifications
TS 6—09—5294—86 Granulated Zinc. Specifications
TS 6—09—5360—87 Phenolphtalein (Indicators). Specifications

3 Sample Selection and Preparation Method

3.1 Laboratory sample selection and preparation to the test is carried out in accordance with the regulatory guidelines for this type of product.

Two parallel test portions are taken from the combined laboratory sample.

3.2 Sample mineralization is carried out in accordance with GOST 26929.

4 Equipment, Materials, Reagents

Atomic and absorption spectrophotometer equipped with the burner for air-acetylene flame, background absorption corrector and sources of resonant radiation of lead, cadmium, copper, zinc and iron (hollow cathode lamps, electrodeless discharge lamps or other equivalent sources). It is allowed to use the spectrophotometer without background absorption corrector subject to the extraction concentration.

Air compressor that complies with the technical instruction requirements for the spectrophotometer, or compressed air in cylinders.

Dissolved and gaseous technical acetylene according to GOST 5457 in cylinders.

Laboratory balance of general purpose with metrological characteristics according to GOST 24104 with the greatest weighing limit of 200 g and accuracy of at least the 2nd grade.

Laboratory balance of general purpose with metrological characteristics according to GOST 24104 with the maximum weighing limit of 500 g and accuracy of the 4-th grade.

Water bath.

Burette 1—1—2—50—0,1 according to GOST 29251.

Volumetric flasks 2—25—2,2—50—2,2—100—2 and 2—1000—2 according to GOST 1770.

Pipettes 2—1—2—1 or 1—1—2—1, 2—1—2—2 or 1—1—2—2, 1—2—2—5 и 1—2—2—10 according to GOST 29169.

Measuring cylinders 1—25 or 3—25, 1—50 or 3—50 according to GOST 1770.

Glasses H-1—100 or H-1—150 according to GOST 25336.

Separatory funnels VD-1—100 or VD-1—250 according to GOST 25336.

Test tubes with sleeve P-4—5—1423 or P-4—10—1423 according to GOST 25336.

Dripper according to GOST 25336.

Laboratory funnels in accordance with GOST 25336.

Ashless filters of 7 or 9 cm diameter according to TS 6—09—1678.

Distilled water in accordance with GOST 6709.

Aqueous ammonia, chemically pure, solution with a mass fraction of 5% in accordance with GOST 3760.

Bidistilled water.

Isoamyl acetate (izopentilasetat) according to TS 6—09—1240, pure, or butyl acetate according to GOST 22300, pure.

Cadmium metal.

Granulated zinc, analytically pure, reagent grade according to TS 6—09—5294 or zinc oxide, chemically pure according to GOST 10262.

Lead nitrate, reagent grade according to GOST 4236.

Ferrous salt and binary sulfurous ammonium salt (Mohr's salt), chemically pure according to GOST 4208.

Copper sulfate, chemically pure according to GOST 4165.

Nitric acid in accordance with GOST 11125, ultrapure or of other grade, distilled; solution in bi-distilled water (1:1) by volume and the solution with a mass fraction of 1 %.

Hydrochloric acid in accordance with GOST 14261, ultrapure or of other grade, distilled; solution in bi- distilled water (1:1) by volume and the solution with a mass fraction of 1 %.

Citric acid, chemically pure according to GOST 3652; solution in bi-distilled water with mass fraction of 20 %.

Sodium 14,]M- diethyldithiocarbamate, analytically pure, reagent grade according to GOST 8864; solution in bi-distilled water with mass fraction of 0.5% (prepared on the day when the analysis is conducted).

Phenolphtalein according to TS 6—09—5360, water-alcohol solution with mass fraction of 1%.

It is allowed to use other equipment, reagents and materials with technical and metrological characteristics that are not worse than these are.

5 Test Preparation

5.1 Laboratory Glassware Preparation

New and heavily soiled glassware after the usual washing in a solution of any detergent is washed with water and rinsed with distilled water. Laboratory glassware cleaning procedure before the use includes the following successive stages: glassware washing with hot nitric acid (1:1) by volume, rinsing with distilled water, washing with hot hydrochloric acid (1:1) by volume, rinsing with distilled water 3-4 times, rinsing with bi-distilled water 1-2 times, drying.

5.2 Standard Solutions Preparation

5.2.1 Key elements of the standard solutions are prepared: for lead in accordance with GOST 26932, cadmium - according to GOST 26933, copper - according to GOST 26931, zinc - according to GOST 26934, iron - according to GOST 4212. It is allowed to use ready-made business solutions with a guaranteed concentration of elements 1000 g/cm^3 based on the nitrate or hydrochloric acid with mass fraction of not less than 1%.

5.2.2 Intermediate element standard solutions are prepared by serial dilution of stock solutions by 10 and 100 times with a solution of nitric acid with mass fraction of 1%. These solutions are stored in the sealed dish no more than a year.

5.2.3 Standard reference solutions are prepared of the intermediate solutions by dilution with the same acid solution as the sample solutions. Element content in the test and standard solutions should not exceed the following operating ranges: for lead 0.1-2.0 mcg/cm^3, cadmium 0.02-1.0 mcg/cm^3, copper 0.05-5.0 mcg/cm^3, zinc and iron 0.1-10.0 mcg/cm^3. Measurement of the absorption in control solutions may be carried out at element content below these limits. The operating ranges of 3-4 reference solutions are enough. Solutions with metal concentration of 1 to 10 mcg/cm^3 are stored no more than a month, those of concentration of less than 1 mcg/cm^3 are prepared daily.

5.2.4 As zero standard, solution of nitric or hydrochloric acid with mass fraction of 1% is used for the sample dissolving and standard reference solutions diluting in this test series.

5.3 Test Solution Preparation

5.3.1 When using dry ashing method or acid extraction ashing, the ash is dissolved in a crucible by heating it in the nitric acid (1:1) by volume based on 1 – 5 cm^3 acid sample portion, depending on the product ashing. The solution is evaporated to moist salts. The sediment is dissolved in 15-20 cm^3 of nitric acid with mass fraction of 1%, quantitatively transferred to a volumetric flask of 25 cm^3 capacity and is adjusted to the mark with the same acid.

In case of incomplete ash dissolution, the obtained solution with the sediment is evaporated to moist salts, redissolved in a minimum volume of hydrochloric acid (1:1) by volume and again evaporated to moist salts and dissolved in 15-20 cm^3 of hydrochloric acid with mass fraction of 1%. The solution is quantitatively transferred to a volumetric flask of 25 cm^3 capacity and adjusted to the mark with the same acid.

In case of incomplete ash dissolution, the obtained solution with the sediment is evaporated to volume of 30 – 40 cm^3 with the hydrochloric acid with mass fraction off 1%, and heated at a water bath or at hot plate at low heat for 0.5 hour. If in this case there is not complete dissolution, the solution is filtered through the washed with the solvent filter, the sediment is washed and discarded, and the filtrate is transferred to a volumetric flask of 50 cm^3 and adjusted to the mark with the same acid.

5.3.2 Using the method of wet mineralization, the obtained mineraliser solution is evaporated to moist salts and the dissolving is continued according to 5.3.1.

5.4 Control Solution Preparation

Control cups (beakers, flasks) obtained with sample mineralizers, pass all the stages of the test solution preparing with the addition of the same amounts of reagents.

5.5 Solution Dilution

If the element content in the test solution is measured above the upper limit of the working content range (5.2.3), the test solution diluting with zero standard is carried out. The dilution factor is selected so that the element content in diluted solution is in the middle of the range (for copper, zinc and iron in the range from about 1 to 3 mcg/cm^3). Dilution factor $K > 1$ is equal to

$$K=Y_2/Y_1,$$

where Y_1 is aliquot volume taken for dilution, cm^3;
Y_2 is diluted solution volume, cm^3.

5.6Extraction Concentration

Concentration is carried out by extracting if:

a) after preliminary measurement, the lead concentration in the initial solution was below 0.1, cadmium - below 0.02 mcg/cm^3;

b) there is a need to improve the accuracy of the analysis;

c) the element content in the initial solution in the following series of measurements is below the achieved in the series detection limit and there is a need for a bilateral evaluation of the element content in the product;

d) background absorption correction is not carried out during the determination of lead, cadmium.

Test solutions aliquots of 10-50 cm^3 volume are put in glasses of 100 or 150 cm^3 depending on the requirements for the concentration degree and control solutions aliquots with the same volume and their volume is adjusted by zero standard to 50 cm^3. Dilution factor of these solutions is considered as 5.5. Simultaneously in the same cups of 50 cm^3, standard reference solutions are poured.

In carrying out the extraction, in order to increase the analysis sensitivity and accuracy, the reference solution with the minimum concentration, obtained according to 5.2.3, standard solutions containing the element by 2 and 10 times lower than the minimum and zero standard prepared according to 5.2.4.

When using spectrophotometers without background absorption correctors, the element concentration in reference solutions taken for extraction, should not exceed the following levels: for lead - 2 mcg/cm^3, cadmium -0.1 mcg/cm^3. 10 cm^3 of citric acid solution is pored into the glasses, 2-3 drops of phenolphthalein solution are added and titrated with ammonia solution until slightly pink colour. The solutions are transferred to a separatory funnels or measuring flasks of 100 cm^3, 5 cm^3 of diethyldithiocarbamate and sodium solution, and 5 cm^3 of ether are poured and shaken for 1 min.

When using a separatory funnels, the lower aqueous layer is discarded after the separation stage and the organic extracts are collected into test tubes and stoppered. For the extraction in the flasks, such amount of bi-distilled water should be poured so that the organic layer was in the throat of the flask, and the organic phase is taken during the measurements by the feed spraying capillary directly, preventing its immersion in the aqueous stage.

In diffuse light, the extracts are stable during the working day.

Concentration factor K <1 equals

$$K=Y_2/Y_1,$$

where Y_1 is the aliquot volume taken to concentration, cm^3;
Y_2 is the volume of the organic phase, Y_2 = 5 cm^3.

5.7 Preparation of the spectrophotometer for use and selection of measurement conditions

Device preparing for use, its starting and putting on the operating mode is carried out according to the attached spectrophotometer technical instructions. Low element concentration measurement features require a careful compliance with the following requirements, helping to reduce the drift and "memory" and to increase the signal to noise ratio:

a) resonant radiation source heat prior to the measurement to obtain the stable radiation intensity, but at least 0.5 hour;

b) adjusting the resonant and non-resonant radiation sources;

c) burner heating before taking the measurements with its simultaneous rinsing with distilled water for 5-10 minutes;

d) monochromator accurate adjustment to the resonance line of maximum radiation at the minimum gap, but the measurements are taken at the maximum monochromator gap;

e) adjusting the burner height and the air/acetylene ratio before each series of measurements at the maximum absorption of one of the standard reference solution.

The most sensitive element absorption lines are used with the following wavelengths: for lead – 283.3 or 217 nm , cadmium -228.8 nm, copper - 324.8 nm, zinc - 213.9 nm, iron - 248.3 nm. Selection of lead resonance line depends on the lamp technical specifications and spectrophotometer and is held for the given device and lamp according to the criterion of greater signal/noise ratio and less sensitivity drift and the zero line value.

6 Conducting of Measurements

6.1 Spraying zero standard in flames (using concentration - its extract), the device readings are set to zero. Then, in order of concentration increasing, standard reference solution (or their extracts) absorption is measured. At the end of the calibration, the zero line position is pointed when zero standard is sprayed.

6.2 absorbance of a small number (5-10) of test and control solutions is measured, washing after each measurement the sprayer and burner system with distilled water or zero standard (for extracts – by ether) to return the signal to the readings close to the zero. The exact measurement of the zero standard absorption and one of the reference standards is repeated the closest according to the concentration of the test solution. If zero line offset and standard absorption change are not observed, the measurements of test solutions absorption are continued, periodically repeating the zero drift control and sensitivity and finishing measuring with the full grading.

Measurement of each solution absorption is carried out at least 2 times.

6.3 If during the measurement, zero line offset or sensitivity change are observed, each small series of test solutions is measured twice in forward and backward sequence order starting and ending with complete gradation. The series volume is determined by the drift speed: the number of solutions in the series should be such that the absorption change in reference standards in consecutive grading do not exceed the ration of 5%. If the zero line offset is not corrected by automatic devices, it should be taken into account by the introduction of amendments to the sample and standard absorption signals. Zero drift within each small measurement series is considered linear.

6.4 Detection Limit Determination

After full series absorption measurements of test solutions, the 20-fold standard solution absorption measurement is carried out with a minimal concentration of any test solution or solution residues mixture with low element concentration. Depending on the drift availability, the measurements are carried out according to 6.2 or 6.3 – according to the same procedure as for the test solutions. Based on statistics obtained, standard (RMS) deviation from the mean value is calculated for a single measurement *S_p, mcg/cm³*. Tripled value of the standard deviation $3S_p$ is considered to be the element detection limit in the solution at P = 0.99.

If the carried out series of measurements include at least 10 solutions with element concentration of below 0.2 mcg/cm³, specific measurements are not carried out, and the standard deviation is calculated according to the formula

$$S_{\text{п}} = \sqrt{\frac{\Sigma(c_i' - c_i'')^2}{2k}},$$

where {c_i - c''_{ii}) is the element concentration divergence in parallel measurement in the /i solution;

k is the umber of solutions.

7 Results Processing

7.1 If device has a computing system for the absorption value concentration calculation, the recommended computer program mentioned in the technical manual of the device should be used.
During the manual processing the graph is plotted for absorbance against concentration. It`s allowed to use a linear, a piecewise-linear or non-linear approximation of a smooth graduated functions. While graph plotting for each small series of measurements, the arithmetic means of absorbance values of standard comparison solutions which were obtained in the two graduations (before and after the test solution absorbance measurements) and corrected by the value of the zero line offset are used. The concentration of the element in the test and reference solutions are determined according to the schedule, graph plotted. Concentration values that are lower than the detection limit of 3Sp shall be equal to zero.
The arithmetic averages of parallel measurements are used during the calculations:

7.2 The element mass fraction for sample cell (m), 1 ppm, is calculated as follows:

$$m = \frac{(c_x - c_k) \cdot Y \cdot K}{p},$$

where c_x — element concentration in the test solution, µgr/cm³;

$c_к$ — concentration arithmetic mean value of the element for parallel control solutions, µgr/cm³;

Y— the initial volume of test solution, cm³;

p — sample weight,

K— dilution factor.

7.3 If the $(c_i' - c_i'')$ difference is less than the detection limit *$3S_p$*, the one-sided assessment is given to one of the highest possible concentration of the element in the product up to one millionth.

$$m_{\text{макс}} < \frac{3S_{\text{п}} \cdot Y \cdot K}{p\sqrt{n}},$$

where *n* — the number of parallel measurements of the test solution absorption.

7.4 The arithmetic mean of the results of two parallel determinations shall be considered a final result of the measurement taken. The final result is rounded to the second decimal place.

7.5 The allowable difference between two parallel results, obtained in a laboratory after several series of measurements (convergence r) depends on the mass fraction of the element in the product and shall not exceed the values specified in Table 1 and P = 0.95.

Table 1

Element	Element mass fraction in product	R repeatability, mln^{-1}	The relative standard deviation of repeatability 100 $S_{r/m}$, %
Lead	0,01 0,1 0,5 1,0	0,0050 0,025 0,081 0,130	18 9 6 5
Cadmium	0,01 0,1 0,5 1,0	0,0034 0,017 0,055 0,090	12 6 4 3
Copper	0,5 1,0 10 30	0,22 0,31 0,76 1,2	16 11 3 1
Zink	1,0 10 50 100	0,34 2,4 9,6 17	12 9 7 6
Iron	10 50 100 200	3,8 9,3 14 20	13 7 5 4

7.6 Allowable discrepancy between the results of tests performed in two different laboratories (R repeatability) depends on the mass fraction of the element in the product and should not exceed the values shown in Table 2 and at P = 0.95.

Table 2

Element	Element mass fraction in product	R repeatability, mln^{-1}	The relative standard deviation of repeatability 100 $S_{r/m}$, %
Lead	0,01 0,1 0,5 1,0	0,014 0,073 0,24 0,39	50 26 17 14
Cadmium	0,01 0,1 0,5 1,0	0,011 0,056 0,17 0,27	40 20 12 9
Copper	0,5 1,0 10 30	0,40 0,64 3,0 6,3	29 23 11 8
Zink	1,0 10 50 100	0,73 4,3 15 26	26 16 11 9
Iron	10 50 100 200	15 38 57 84	55 27 20 15

Note - In the intervals between those levels mentioned in Tables 1 and 2 there may be a linear interpolation of repeatability and reproducibility parameters. If the extraction concentration was performed during the tests, the levels specified in Tables 1 and 2, should be compared with the conventional concentration, taking into account the value of the concentration factor. i.e. $m_{усл.}=m/K$

7.7 Possible values of the systematic component measurement error of the mass fraction of lead, cadmium, copper and zinc or iron in any probe at permitted by methodic procedure changes of influencing factors should not exceed ± 0,1 m.

Universal Decimal classification 664:546.56.06:006.354 | ICS 67.050 **H09** | All-Union Classification for Standards and Specifications 9109 9209

Keywords: food products, food raw materials, toxic elements, methods of analysis, atomic absorption analysis.

FORTIFICATION ASSESSMENT COVERAGE TOOLKIT (FACT) SURVEY IN KAZAKHSTAN, 2016