Russia's experience in assessing and managing the public health risk posed by contaminants intake with foods

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Legislation framework for food safety aspects in the Russian Federation

Federal Law “On Sanitary and Epidemiological Welfare”

"Products ... should not have harmful effects on a human and environment ..."

Federal Law “On Protection of Consumers' Rights”

“... The consumer has the right to safe products ...”

Federal Law “On Technical Regulation”

“... Product Safety - absence of unacceptable risk.
Risk - a combination of the probability and severity of injury ...” (Article 3)

Decision of the Customs Union Commission “On the equivalence of sanitary, veterinary and phytosanitary measures and risk assessment”

“... The risk to human life and health is the criterion for the appropriate level of sanitary and phytosanitary protection of the population ...” (Article 6)

Provisions of the laws of the Russian Federation are similar to those

- UN Resolution 39/248 “Guidelines for Consumer Protection”
Product groups, the priority for safety assessment in the Russian Federation and the Customs Union

- Group 04. Dairy products
- Group 15 Fats and oils of animal or vegetable origin
- Group 17 Sugar and sugar confectionery
- Group 22 Alcoholic and nonalcoholic beverages
- Group 61 Garments, knitted items
- Group 64 Shoes
- Group 84 Nuclear reactors
- Group 95 Toys, games and sports requisites
Food safety is ensured by the establishment of mandatory requirements under the Technical Regulations (TR)

At the beginning of 2014 Russia 10 TR on food products entered into force

Risk assessment procedure in the development of technical regulations:

- Hazard identification for further risk assessment.
- Identification of potential consumers.

**Methods:** analysis of statistical data, research reports, research technologies, raw materials and so on.

TR developer

- Establishment of a minimum sufficient requirements for the product.

**Methods:** toxicological or epidemiological studies, risk assessment, the development of “risk-based” requirements.

Scientific organizations

- Establishing requirements for the conformity assessment of products.

**Methods:** statistical analysis of violations, negative effects, expert reviews.

TR developer

Feature in the Russian Federation: safety, for which regulations are still under development or planning, are determined by Uniform sanitary and epidemiological and hygienic requirements for goods subject to sanitary and epidemiological supervision (control)
Federal services and agencies:

- Federal Service for Supervision of Consumer Rights Protection and Human Welfare (Rospotrebnadzor)
- Federal Customs Service (FCS)
- The Federal Service for Alcohol Market Regulation (Rosalkogolregulirovanie)

Federal ministries, their subordinate agencies, services, supervisions:

- Ministry of Industry and Trade (Ministry of Industry)
- Federal Agency for Technical Regulation and Metrology (Rosstandart)
- Ministry of Agriculture (Minselkhoz)
- Federal Service for Veterinary and Phytosanitary Surveillance (Rosselkhoznadzor)
Federal Service for Supervision of Consumer Rights Protection and Human Welfare (Rospotrebnadzor)

Functions:

- Supervision of compliance with legislation, measures to prevent and minimize risk
- Examination and assessment of product risk
- Development of methodology for the regulatory and procedural framework for health risks assessment and management

84 territorial Rospotrebnadzor units

85 centers for Epidemiology and Hygiene

29 research institutions
“... In order to achieve the common goal of ensuring a high degree of human life protection the health food law is based on risk analysis data ...”

“The risk assessment is based on the available scientific evidence and is performed independently, objectively and transparently ...”

Art. 6 of Regulation 178/2002 of the European Parliament and the Council from 28 January 2002 on the general principles of food law, establishment of the European security and control of food products and methods of securing the safety of food products
“...Risk assessment should be carried out in accordance with the “Declaration of Principles on the Role of risk assessment in the field of food safety” and include four stages of risk assessment: hazard identification, hazard characterization, exposure assessment and risk characterization.

Risk assessment should be based on all available scientific data and use the available quantity information as much as possible.

Risk assessment should be based on realistic exposure scenarios, taking into account different situations that are defined by risk assessment policy. Population groups with high sensitivity and with excess exposure to risk are taken into account. The probability of occurrence of acute, chronic (including long-term nature), as well as other cumulative and / or combined adverse health effects (depending on the situation) should be taken into account... “

FRAMEWORK FOR THE ASSESSMENT OF PUBLIC HEALTH RISKS ASSOCIATED WITH FOOD CONSUMPTION

Hazard Identification
- determining in accordance with the fundamental scenarios the impact of specific risk factors and associated potential health problems;
- identification of risk contingent, determination of critical points;
- danger in the process of food production within the HACCP system.

Dose-Response Assessment (for chemical factors)
- determining safe levels of exposure to factors having action threshold;
- parameterization of the correlation “exposure - effect (response)” for nonthreshold action factors.

Exposure Assessment
- qualitative and quantitative assessment of the severity, frequency and duration of exposure;
- assessment of exposure pathways using a scenario approach, taking into account the levels of product consumption (maximum, recommended, actual).

Risk Characterization
- evaluation of risk acceptability and its classification for individual factors and products in general;
- integrated risk assessment of the impact of various production factors;
- risk description as the probabilities of the individual effects with the quantitative or semi-quantitative characteristics.
Evaluation matrix of health risk level for assigning products to categories of risk deliveries

<table>
<thead>
<tr>
<th>Probability of health damage by using products</th>
<th>Characteristics of health injury severity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Severe</td>
</tr>
<tr>
<td>Very high</td>
<td>Very high</td>
</tr>
<tr>
<td>High</td>
<td>Very high</td>
</tr>
<tr>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Probability</td>
<td>1/10</td>
</tr>
</tbody>
</table>

Poor quality products with “very high” and “high” levels of health risk are proposed to add to the information system of the Eurasian Economic Community in the field of technical regulations, sanitary and phytosanitary measures, and integrated information systems for foreign and mutual trade of the Customs Union.
New approaches to production risk assessment are created

Allow to evaluate:

- **health risk evolution** during the period of contact with the consumer products;
- **risk level** for different, including sensitive groups of consumers;
- **simultaneous effect** of production heterogeneous risk factors per person;
- **structure of risk factors and responses**;
- **model** health risk for given scenarios.

\[
\begin{align*}
\frac{dD_{ij}}{dt} &= \alpha_i D_{ij} - \beta_i (1 - D_{ij}) + \sum_k \gamma^1_{ki} f_{ki}(\eta^I_k) + \sum_k \gamma^2_{ki} f_{ki}(\eta^II_k) + \sum_k \gamma^3_{ki} f_{ki}(\eta^III_k) \\
p_{ki} &= \varphi^I_{ki}(C^V_k - \eta C^V_k) - \varphi^II_{ki}(C^M_k - \eta C^V_k) + \varphi^III_{ki} \sum_l (\mu_{kl} C_l + \mu_{lk} C_k) \\
\frac{dG_{ik}}{dt} &= \sum_{i,j} \psi_{ij} (D_{ij}) \nu_{ij} \\
D_{ij} &= D_{ij} - \sum k, l D_{ij}
\end{align*}
\]
Risk management measures are differentiated by its characteristics

<table>
<thead>
<tr>
<th>Risk evaluation index</th>
<th>Production risk characteristics</th>
<th>Risk management measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 0.05</td>
<td>Negligibly low risk</td>
<td>In cases of complaints and claims</td>
</tr>
</tbody>
</table>
| 0.05-0.35             | Moderate risk                   | - Risk communication (labeling)  
                          |                                 | - Minimizing risk at the stages of design and production |
| 0.35– 0.6             | High risk                       | - Inclusion in the category of risk deliveries  
                          |                                 | - Risk communication 
                          |                                 | - Limiting the issuance and use |
| more than 0.6         | Very high risk                  | - Inclusion in the category of risk deliveries  
                          |                                 | - Risk communication 
                          |                                 | - Product recall |

* *Health Risk Analysis. 2013. № 4. (rus, eng)*
RISK ASSESSMENT OF GASTROINTESTINAL DISEASES DUE TO EXPOSURE OF TETRACYCLINE RESIDUAL CONCENTRATIONS IN FOOD

Hazard identification

Tetracycline group - bacteriostatic antibiotics disrupt complex formation between transport RNA and ribosome, which leads to a suppression of protein synthesis. They promote resistant flora growth, pathogenic and commensal (opportunistic) on the background of the continuing activity against obligate anaerobic flora.

Hazard characteristics

Critical effects - increasing microflora resistance to tetracycline and intestinal microflora imbalance, which leads to the development of gastrointestinal tract diseases.

Comparison of acceptable daily doses and maximum allowable levels of tetracyclines in meat products

<table>
<thead>
<tr>
<th>Acceptable levels</th>
<th>FAO/WHO</th>
<th>European Union</th>
<th>Customs Union</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADI, µg/kg per day</td>
<td>30</td>
<td>3</td>
<td>0.38</td>
</tr>
<tr>
<td>MRL, µg/kg:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- meat (muscle tissue)</td>
<td>100</td>
<td>100</td>
<td>10</td>
</tr>
<tr>
<td>- liver</td>
<td>600</td>
<td>300</td>
<td>10</td>
</tr>
</tbody>
</table>

*Population Health and Habitat. 2012. № 7 (232) (rus).*  
MATHEMATICAL SIMULATION OF DIGESTION PROCESSES

Gastrointestinal tract presentation in the form of biomechanical system

\[
\begin{align*}
\frac{\partial}{\partial t} (\alpha_q p_q) + \nabla \cdot (\alpha_q p_q v_q) &= 0 \\
\frac{\partial}{\partial t} (\alpha_q p_q v_q) + \nabla \cdot (\alpha_q p_q v_q v_q) &= \\
&= -\alpha_q \nabla p - \nabla p_q + \nabla \cdot \sigma_q + \alpha_q \rho_q g + \sum_{p=1}^{n} R_{pq} \\
\sigma_q &= \alpha_q \mu_q (\nabla v_q + \nabla v_q^T) + \alpha_q (\lambda_q - \frac{2}{3} \mu_q) \nabla \cdot v_q I
\end{align*}
\]

- Russian Journal of biomechanics. 2013. № 4. (rus)
- Health Risk Analysis. 2014. № 2. (rus,eng)
RISK ASSESSMENT OF INTESTINAL MICROFLORA IMBALANCE DUE TO THE EFFECTS OF TETRACYCLINE RESIDUAL CONCENTRATIONS IN FOOD

Dependence model of tetracycline inhibition for various bacteria growth

\[ ADI = \frac{MIC_{50} \times \dot{i}}{AOD \times MF \times W} \]

where \( MIC_{50} \) - minimum inhibitory concentration;
\( M \) - mass of the intestinal contents;
\( AOD \) - bioavailable oral dose;
\( MF \) - modifying factor;
\( W \) - body weight

- Population Health and Habitat. 2012. № 7 (232). (rus)
RISK ASSESSMENT OF INTESTINAL MICROFLORA IMBALANCE DUE TO THE EFFECTS OF TETRACYCLINE RESIDUAL CONCENTRATIONS IN FOOD

Exposure assessment

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum daily intake (MDI), µg/kg</td>
<td>3.2</td>
<td>89.4</td>
<td>160.3</td>
<td>360.95</td>
</tr>
<tr>
<td>Tetracycline concentration in the gastrointestinal tract, µg/kg</td>
<td>0.069</td>
<td>1.79</td>
<td>3.2</td>
<td>7.2</td>
</tr>
</tbody>
</table>

Risk characteristics

- **Dermatitis**: 0.9% cases
- **Digestion diseases**: 4% cases
- **Food allergy**: 0.1% cases

*Population Health and Habitat. 2012. № 7 (232) (rus).*
SAFETY ASSESSMENT FOR PUBLIC HEALTH OF RACTOPAMINE WHEN ENTERED WITH FOOD

Hazard Identification

Ractopamine hydrochloride—phenethanolamine-agonist of β-adrenergic receptors, stimulates β2-adrenergic receptors in the bronchi, skeletal muscle, heart, blood vessels and other organs. Currently, ractopamine is prohibited for use in 80 countries, including the EU, Russia, China.

Main group of adverse effects:

- Non-carcinogenic - impairment of the cardiovascular system function.
- Carcinogenic - development of uterine leiomyoma.

Evaluation of dependence “Exposure – effect”

Recurrence relation of accumulating risk of cardiovascular system functional disorders (non-carcinogenic risk)

\[ R_{t+1} = R_t + (\alpha \cdot R_t + \beta \cdot D)C \]

- \( R_{t+1} \) — risk of disturbances at time \( t + 1 \);
- \( R_t \) — risk of disturbances at time \( t \);
- \( \alpha \) — coefficient of risk evolution due to natural causes,
- \( \beta \) — coefficient of ractopamine impact,
- \( C \) — interim empirical coefficient (for daily averaging \( C = 0.00274 \)),
- \( D \) — ractopamine dose [µg/kg].

Dependence “dose effect - cancerogenic (uterus hyperplasia)”

\[ R = \alpha \cdot D \]

- \( R \) — incidence of uterine hyperplasia,
- \( D \) — ractopamine dose [mg/kg]
- \( \alpha \) — model parameter

Commission Codex Alimentarius - ADI, 1 µg/ kg/day

* Bulletin of RAMS. 2013. № 6 (rus)
SAFETY ASSESSMENT FOR PUBLIC HEALTH OF RACTOPAMINE INTAKE WITH FOODS

Exposure assessment

Ractopamine dose when entered with food products with a residual content at the levels specified by Codex Alimentarius Commission and the Customs Union

<table>
<thead>
<tr>
<th>Maximum permissible level</th>
<th>Ractopamine content, µg/kg</th>
<th>Dose, µg/kg body weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Codex Alimentarius</td>
<td>10</td>
<td>0.0371</td>
</tr>
<tr>
<td>Customs Union*</td>
<td>3</td>
<td>0.011</td>
</tr>
</tbody>
</table>

* - lower limit of detection in the tissues (liquid chromatography with voltammetric (electrochemical) detector

Risk characteristics

Reduced risk index of cardiovascular system functional disorders at a content of ractopamine in meat products is:
- at the content 10 µg/kg – 0.47 (high risk)
- at the content 3 µg/kg – 0.14 (moderate risk)

Carcinogenic risk for all the studied scenarios is less than 1.32·10⁻⁶ and characterized as acceptable (accessible)

Forecast of ractopamine cumulation dynamics based on the processes of its elimination from the body

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Risk characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 0.05</td>
<td>negligible risk (the upper limit of acceptable risk)</td>
</tr>
<tr>
<td>0.05 -0.35</td>
<td>moderate risk</td>
</tr>
<tr>
<td>0.35 – 0.6</td>
<td>high risk</td>
</tr>
<tr>
<td>more than 0.6</td>
<td>very high risk</td>
</tr>
</tbody>
</table>

* Bulletin of RAMS. 2013. № 6 (rus)
Hazard Identification

Critical effects: development of methemoglobinemia, carcinogenic effects
Most sensitive population group – children:
- higher levels of liquid intake per kg body weight;
- increased risk of gastrointestinal infections;
- higher compared to adults tendency of hemoglobin to oxidation;
- imperfection of the gastrointestinal tract, leading to an increase in gastric pH and creating an enabling environment for nitrate-reducing microflora;
- lower activity methemoglobin reductase.

Evaluation of dependence “exposure – effect”

Based on the published results of research nitrates activities exponential models of response dependence on the level of nitrates administration with food of plant origin are built

Background information


Models ”exposure-response”

Non-carcinogenic effects (methemoglobinemia)

$y = 1 - e^{-0.000639x}$

Cancerogenic effect

$y = 1 - e^{-1.44E07x}$

* Population Health and Habitat. 2013. № 11 (rus)
JUSTIFICATION OF NITRATES PERMISSIBLE LEVELS IN CROP PRODUCTION BY HEALTH RISK CRITERIA

Exposure assessment

Administration levels of nitrates with crop production and dose at different exposure scenarios

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Scenario 1 (maximum consumption)</th>
<th>Scenario 2 (1 to 11)</th>
<th>Scenario 3 (11 to 18)</th>
<th>Scenario 4 (18 to 60)</th>
<th>Scenario 5 (older than 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrate intake mg/day</td>
<td>202.2</td>
<td>47.9</td>
<td>70.5</td>
<td>87.5</td>
<td>84.0</td>
</tr>
<tr>
<td>Nitrate dose mg/kg/day</td>
<td>3.4</td>
<td>2.1</td>
<td>1.3</td>
<td>1.5</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Risk characterization

Non-carcinogenic risk (likely levels of methemoglobin) 0.24% - 1.03%

Background level of methemoglobin 1-3%. Health violations are observed at levels more than 10%

Levels of carcinogenic and non-cancerogenic risk do not exceed maximum permissible

Maximum permissible level (1×10^-6 - 1×10^-4)

* Population Health and Habitat. 2013. № 11 (rus)
The use of health risk assessment methodology allows to prove the hygienic standards of the Customs Union and the Russian Federation, the content of residual tetracycline and ractopamine, nitrates, and argue the position of the member countries of the Customs Union on the issue of food safety.
Key areas for further improvement and harmonization of approaches and tools of the Russian Federation in the field of food safety for human health (including, in the framework of bilateral relations):

- convergence of scientific approaches to assess and manage health risks of consumers;
- harmonizing assessment and risk management tools;
- experience exchange and constructive practice discussion of risk assessment and management;
- improving the system of registration and accounting data on the incidence of harm to consumers;
- integration of information systems and databases of the Russian Federation in the information space of other countries.
Thank you for your attention!