

Popcorn quantities consumed by toddlers as basis for assessment of possible health risks

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Popcorn is made from puffed corn, to which seeds from thorn apples or henbane may adhere. These impurities contain tropane alkaloids, such as atropine and scopolamine. Even in low doses they influence the heart rate and central nervous system. Typical symptoms are dizziness, headaches and nausea.

In the EU Member States, monitoring authorities are constantly observing concentrations of tropane alkaloids in analyses of food samples. Corn products are also affected to a lesser extent, meaning that popcorn made from these products can be equally affected.

The BfR sets out consumption amounts of popcorn by children aged 3 to under 5 years in detail. They can act as a reference for the food monitoring authorities of the German federal states ("Länder") and all commercial operators, concerning the assessment of possible health risks, which may emerge from popcorn contaminated with tropane alkaloids.

New data based on the representative "The Children's Nutrition Survey to Record Food Consumption" (KiESEL study) substantiate assumptions about popcorn consumption habits. Based on this, it is realistic that children between 3 to under 5 years eat up to 100 g of popcorn during a single consumption event.

A database from the market research company MINTEL, in which new products are analysed (Global New Products Database; GNPD), provides additional information about eating habits. Of the 185 popcorn products catalogued within the database, over 90 packs contain 100 g or more – including products with a design aimed at children. However, conclusions about the period over which this quantity is consumed, or by how many people, cannot be drawn based on this market data.

The BfR has determined that toddlers can consume a large popcorn portion of 92.9 g in a single day, based on data from the VELS study ("Consumption Survey of Food Intake among Infants and Young Children"). This quantity is suitable for considering short-term high intakes and for comparison with reference values for the assessment of acute toxicity, such as an acute reference dose (ARfD), but does not reflect long-term intakes.

The European Food Safety Authority (EFSA) gives the ARfD for tropane alkaloids as being 0.016 µg per kilogram of body weight. This derivation is based on observations in 20 healthy young male adults, concerning temporary reduction in heart rate and effects on the central nervous system, such as dizziness, headaches and nausea. Taking a maximum dose, where no toxic effect occurred (NOAEL; no observed adverse effect level), of 0.16 µg/kg body weight (BW) as a basis and applying an uncertainty factor of 10 to take individual differences into account, a group ARfD of 0.016 µg/kg BW was derived with regard to the sum of (-)-hyoscyamine and (-)-scopolamine.

1 Subject of the assessment

The German Federal Institute for Risk Assessment (BfR) is concerned with a detailed presentation of quantities of popcorn consumed by children aged from 3 to under 5 years. The context is the health risks which may result from popcorn contaminated with tropane alkaloids. The EFSA has derived an acute reference dose (ARfD) of 0.016 µg/kg BW (sum of atropine and scopolamine). Based on the VELS study, the BfR worked with a consumption amount for popcorn of 92.9 g per day for children aged 3 to under 5 years. Since the health risk is an acute risk, this consumption quantity has been derived as a corresponding short-term high intake quantity.

2 Methodical contexts for the consumption quantity recorded

Consumption data was taken from the “Consumption Survey of Food Intake among Infants and Young Children” (VELS study) as a data basis for food consumption for children (Heseker et al. 2003; Banasiak et al. 2005). The abbreviation VELs stands for „Verzehrsstudie zur Ermittlung der Lebensmittelaufnahme von Säuglingen und Kleinkindern für die Abschätzung eines akuten Toxizitätsrisikos durch Rückstände von Pflanzenschutzmitteln“ (Consumption study for recording the food intake of infants and toddlers for the estimation of an acute toxicity risk from plant protection product residues). Between 2001 and 2002, the study was conducted on 816 infants and toddlers aged 6 months to under 5 years all over Germany. The parents recorded all consumed foods in two 3-day dietary records for each child.

For determining the consumption of popcorn, the consumption data for children aged 3 to under 5 years considering individual body weights were taken as a basis. Due to the presence of single-day consumption data, two 3-day nutritional protocols are suitable for exposure assessments for both acute and chronic health risks.

Short-term consumption of popcorn, coded as puffed corn in the VELS data, was recorded in g/day and g/kg BW and day for exposure assessment. 37 (12.5 %) out of 297 children in the specified age group consumed popcorn and/or puffed corn on at least one of the six days. The maximum daily consumption for the six days was recorded on an individual level for each of these children. The daily quantity per person may consist of several portions distributed over the day, which have been summed. The individual maximum daily consumption quantities of popcorn calculated in this manner is revealed to be 92.9 g per day and 5.02 g per day per kg body weight and day respectively for the 95th percentile of consumers.

The consumption quantities recorded here are related to the condition of the food as eaten, i.e. no back calculations were made to the raw unprocessed foods, as for example in the assessment of pesticide residues. Due to the few consumption events, and partwise little detailed information, consumption quantities for popcorn could not be differentiated by proportions of other ingredients, such as sweet or salty popcorn. This means that the stated consumption quantity cannot be directly converted into a consumption quantity for non-puffed corn, as weight proportions for other ingredients such as sugar must be considered.

3 Plausibility checks for consumption quantities recorded

a) KiESEL study

As an update to the VELS study, the BfR is currently performing a nationwide representative study known as the “KiESEL study”, which stands for “**K**inder-**E**rnährungsstudie zur **E**rfas-

sung des Lebensmittelverzehrs" (The Children's Nutrition Survey to Record Food Consumption"). The study is paired with the "German Health Interview and Examination Survey for Children and Adolescents" ("KiGGS Wave 2") by the Robert Koch Institute (RKI) as a module.

The food intake of children has been documented by the families in a weighing record for three consecutive days, and in a single-day weighing record for an independent day. The participants were provided with a set of kitchen scales in order to weigh the food. Consumption outside the home was also noted in the food diary and the quantity consumed was estimated with the help of quantity information on packaging or the KiESEL photobook. The field phase of this study has ended, and data is currently being prepared for evaluation. Systematic data analysis is still not possible at the moment.

Figure 1: Portion sizes of 50 g, 100 g and 150 g of popcorn



Consumption amounts for popcorn could be determined from the provisional consumption data, by screening the already electronically recorded KiESEL dietary records, of which some will be described below. The consumption of a 100 g pack in the cinema has been recorded for a 3-year-old individual. A 2-year-old child consumed 50 g of popcorn at home, this quantity was weighed with the KiESEL scales. Another 2-year-old child consumed 100 g of popcorn during a carnival parade. The consumption of 69 g of sweet popcorn during a cinema visit has been recorded for a 4-year-old child. This current data shows that a popcorn consumption of up to 100 g is realistic for the age group in question.

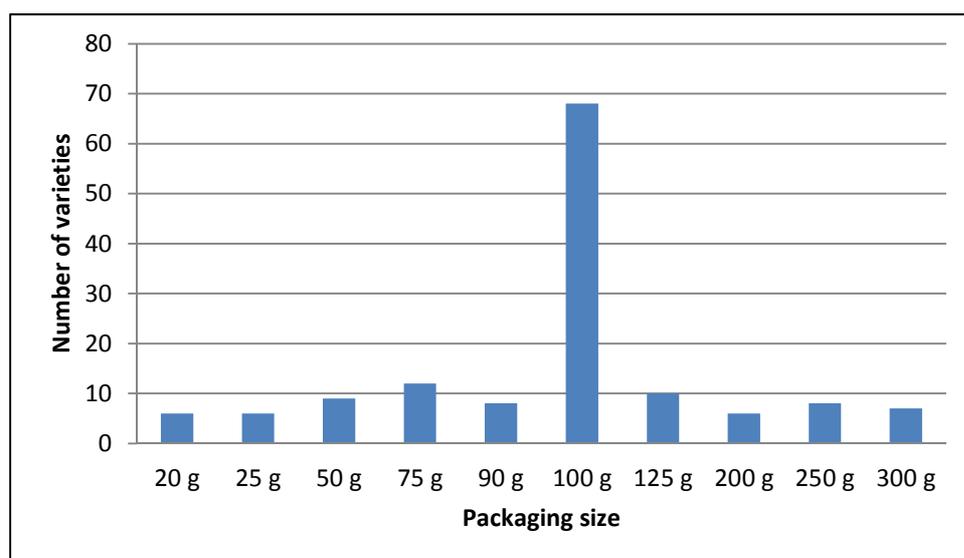
Furthermore, as part of KiESEL, three portion sizes of commercially available ready-to-eat sweet popcorn (50 g, 100 g, 150 g) were reconstructed, with a suitable vessel used to determine volumes. Figure 1 shows that 50 g is equivalent to approx. 500 ml, 100 g to approx. 1000 ml and 150 g to approx. 1400 ml.

b) MINTEL database evaluation

Newly released products are analysed and categorised (ingredients, innovative features, marketing, packaging etc.) in the "Global New Products Database" (GNPD) database by the market research company MINTel. All information visible on the exterior of the packaging is listed, documented with photos and recorded electronically.

Various popcorn products have been researched and their packaging sizes recorded in the GNPD. The research here was conducted in the category 'Foods' and the sub-category 'Snacks', with the Snacks sub-category being restricted to popcorn. Furthermore, only search results from Germany were filtered. A restriction to the time at which the products were introduced onto the market was not made. Products with the following additional ingredients were excluded: Chocolate, natural orange flavouring, shrimp, yeast extract, cocoa and cocoa products, and corn meal.

Figure 2: Pack sizes of popcorn



Research conducted in June 2018 provided 185 different products. A graphic representation of these different pack sizes is set out in Figure 2. Several products with packaging designs aimed at children contain 100 g or more. However, it cannot be concluded from the data whether the packs were consumed by a single child on a single day.

4 Results

Food monitoring authorities in the EU are constantly registering concentrations of tropane alkaloids when analysing food samples – including, to a lesser extent, puffed corn products. Popcorn made from puffed corn may therefore contain tropane alkaloids, which affect the heart rate and central nervous system already in low doses. The EFSA gives the ARfD for tropane alkaloids as being 0.016 µg per kilogram of body weight. The BfR substantiates popcorn consumption quantities for toddlers: Current data from the KiESEL study proves that a single high consumption quantity of 92.9 g, and even up to 100 g per day, is realistic for children aged 3 to under 5 years.

Market research by the MINTEL database also proves that the vast majority of popcorn products on offer are already marketed in equivalent sizes. On viewing the information, it should be noted that distinctions cannot be made between pure popped corn and ready-to-eat products (including sugar and oil, if applicable) using existing consumption data.

Further information on the subject from the BfR website:

High tropane alkaloid levels in cereal products (Opinion of the BfR from 13 November 2013): <https://www.bfr.bund.de/cm/349/high-tropane-alkaloid-levels-in-cereal-products-health-impairments-are-possible-in-individuals-with-heart-problems.pdf>



BfR “Opinions app”

5 References

Banasiak U, Heseker H, Sieke C, Sommerfeld C, Vohmann C (2005): Abschätzung der Aufnahme von Pflanzenschutzmittel-Rückständen in der Nahrung mit neuen Verzehrsmengen für Kinder. Bundesgesundheitsbl – Gesundheitsforsch – Gesundheitsschutz 1, 48:84-98

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MINTEL. (2016). Mintel GNPD: Global New Products Database. Mintel Group Ltd, 11 Pilgrim Street, London, UK EC4V 6RN

About the BfR

The German Federal Institute for Risk Assessment (BfR) is a scientifically independent institution within the portfolio of the Federal Ministry of Food and Agriculture (BMEL) in Germany. It advises the German federal government and German federal states (“Laender”) on questions of food, chemical and product safety. The BfR conducts its own research on topics that are closely linked to its assessment tasks.

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