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UNDISTURBED ANALYSIS

HOW TO AVOID CONTAMINATION IN FOOD ANALYSIS

The analysis of food for contaminants such as heavy metals, pesticides, or other toxic substances is a central component of quality control and consumer protection. Regulatory frameworks such as Regulation (EU) 2023/915 establish clear limits for undesirable substances in food. Modern analytical methods such as ICP-MS enable the reliable detection of even the lowest concentrations. Especially in routine analysis of food and feed, reproducible, contamination-free sample preparation is crucial for valid results.

But this is precisely where a frequently underestimated problem lies: The greatest source of error often lies not in the analysis itself, but one step before it – in sample preparation. For measurement results to be valid, a sample must meet two fundamental requirements: It must be homogeneous and representative.

Mechanical milling is necessary to ensure these preconditions. At the same time, the properties to be analyzed must not be altered in the process, for example, by contamination. Tool wear during the milling process is inevitable, however, and can unintentionally introduce metals into the sample. These metals can influence the analysis result.

In extreme cases, this means:

Not only is the sample analyzed - but also the tool used.

Why is abrasion a problem?

During grinding, metallic particles from tools can be introduced into the sample. In food and feed analysis, this is particularly critical, as elements such as lead, cadmium, nickel, or chromium are toxicologically relevant and subject to strictly regulated limits.

Even small additional contaminants can lead to samples being incorrectly classified as exceeding limits or to trends in monitoring programs appearing distorted.

For laboratories, this poses a significant risk – ranging from unnecessary re-analyses to incorrect evaluations. Even small additional inputs during sample preparation can therefore have significant consequences. Sample preparation is thus not a neutral step, but a potentially decisive factor influencing the analytical result.



RETSCH Cutting Mill SM 50

Purpose of the study

This study aimed to systematically investigate how different tool materials influence heavy metal contamination during the milling process.

For this purpose, the cutting mill SM 50 was used in two configurations: a stainless steel version and a low-heavy-metal variant based on an aluminum / steel combination.

A key feature of the SM 50 is the simple and flexible interchangeability of the grinding tools. This allows the system to be specifically adapted to different samples and analytical requirements. The focus is on a clear approach: abrasion must not only be accepted, but actively controlled.



Tool-free replaceable
milling chamber of the SM 50



Patented push-fit system: easily replaceable milling chamber of the SM 50 cutting mill.

Materials and methods

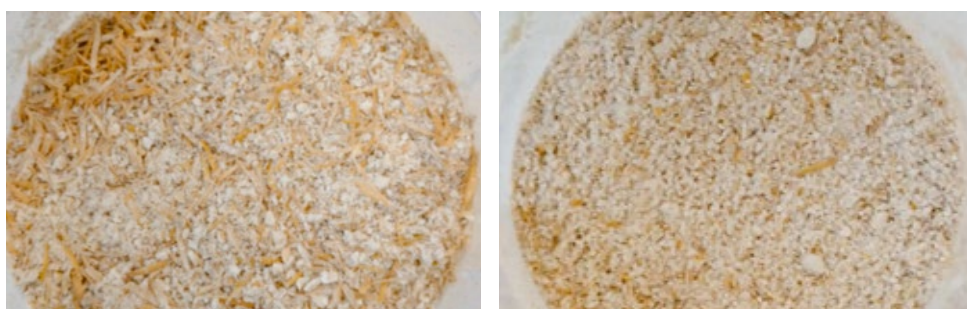
Elemental concentrations were determined using inductively coupled plasma mass spectrometry (ICP-MS), a well-established method for the quantitative analysis of trace elements in food samples with high sensitivity and accuracy.

Two different samples were selected as test materials to represent both typical and extreme conditions. Buckwheat served as a low-abrasion, representative food sample. Oats with husks were used as a highly abrasive worst-case scenario.

The study examined the influence of the tool material and the grinding intensity on sample contamination. Different grinding tools were used, along with coarse 2 mm and fine 0.75 mm sieves. Grinding was performed at 4,000 rpm.



Pictures of the two samples before grinding: buckwheat (left) and oats with husks (right).



Oats with husks after grinding, using a 2 mm sieve (left) and a 0.75 mm sieve (right).

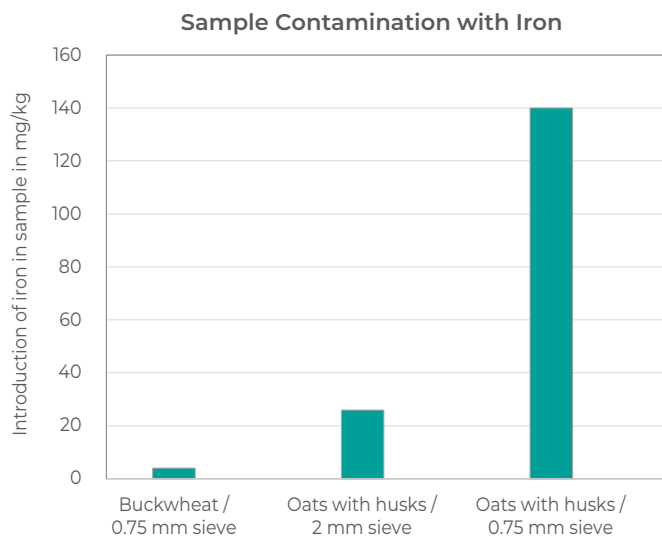
A homogenized sample, which was prepared without any material-related contamination, was used as a reference. This ensures that only the sample's original element concentrations are recorded and used as the basis for determining the contamination introduced by the mill.

Results and interpretation

Factors that influence abrasion intensity

The SM 50 with a stainless steel grinding chamber was used to assess the abrasion intensity. Since iron is the main component of stainless steel, its content in the material serves as an indicator of abrasion intensity.

The results show a significant increase in iron content relative to the reference:



There is a clear correlation between the sample matrix, process parameters, and abrasion intensity. As the abrasiveness of the sample increases, abrasion of the grinding tools rises significantly. At the same time, more intensive grinding - for example, using finer sieves - further amplifies this effect.

Particularly striking is the sharp increase observed when oats are combined with a fine sieve. This can be attributed to increased mechanical stress as well as longer residence times in the grinding chamber.

The results clearly demonstrate that abrasion is not a constant effect. It is largely determined by the properties of the sample and the selected process parameters.

Heavy metal contamination analyses - using buckwheat as an example

Buckwheat is a typical sample encountered in everyday laboratory work, and grinding it is sometimes challenging due to its material properties. Depending on the mill, this can result in insufficient fineness, low throughput, or increased cleaning effort. The SM 50 is well-suited for this purpose.

The measurement results show the extent of contamination caused by the SM 50 and that it occurs even under mild conditions; see Table 1.

Element	Reference	SM 50		Regulatory assessment
		variant with low heavy-metal content	stainless steel variant	
Chromium (CR) [mg/kg]	0.21	0.49	0.80	no defined legal maximum
Nickel (NiR) [mg/kg]	0.15	0.26	0.38	0.5 mg/kg (cereals, in accordance with regulation (EU) 2023/915)

Table 1: Heavy metal concentrations in reference and SM 50-treated buckwheat samples (low heavy-metal and stainless steel variants) compared to regulatory limits.

In particular, the use of stainless steel leads to a strong increase in chromium and nickel content. Clearly, the contamination introduced using the aluminum-based configuration with low heavy-metal content is smaller.

Compared to regulatory limits, the measured concentrations remain within the permissible range. Nevertheless, it is evident that the nickel content increases significantly when using the stainless steel version of the grinding chamber insert. No specific maximum levels have been established for chromium, so the evaluation is conducted without a direct regulatory limit. An approximately fourfold increase in chromium content in the stainless steel variant is observable solely due to sample preparation.

This makes it clear that even moderate abrasion can become analytically relevant under unfavorable conditions.

The results allow for the unambiguous assignment of the measured elements to the tool material used. The observed elements can be traced back to the alloy composition of the respective component. The analysis result thus bears the tool's fingerprint.

Conclusion and added value of the SM 50

The results clearly show that sample preparation in food and feed analysis has a direct impact on the quality and reliability of analytical results.

Particularly with abrasive matrices, the carryover of metals can reach levels that are relevant for regulatory assessments.

At the same time, adjusting the process parameters – for example, by selecting the sieve size – allows for additional control of mechanical stress and thus of abrasion.

The targeted selection of suitable materials and process parameters is therefore not an optional step, but an integral part of a valid analytical strategy.

The overall aim is a sample preparation process that ensures both sufficient homogenization and minimal contamination of relevant elements. Samples remain representative, analytical results are reliable, and regulatory requirements are consistently met.

Key message

The quality of the analysis begins with sample preparation.

It is not only the sample that determines the result – but also the equipment used and the grinding parameters.

The cutting mill SM 50 provides a system that allows for control of abrasion and adaptation to the specific application by easy exchangeable milling tools – ensuring reproducible and reliable analytical results.



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