

Introduction of Z-Score Arrow Ranges (ZSAR) in proficiency testing

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Introduction

DUCARES organizes proficiency tests (PT) in the food and feed area, formerly known as the Agricultural Laboratories Quality Service (KDLL) scheme. The KDLL PT program exists since 1988 and is ISO/IEC 17043 accredited.

ISO/IEC 17043 states that “if the proficiency testing provider issues statements of participation or performance, they shall contain sufficient information to not be misleading.”

Most PT providers, however, do not calculate the performance of participants that report results that are below the limit of quantification (LOQ), so-called truncated results (< results). Therefore PT providers are stimulated by accreditation bodies to provide information about the participant’s performance for truncated results.

Methods (ZSAR and ISO 13528)

The draft ISO standard 13528 describes three options how to deal with truncated results in statistical calculations.

These three different approaches are:

- removal of truncated values
- retaining the truncated values but removal of the ‘<’ sign
- replacing the truncated results with half of the limit value

In daily practice, DUCARES leaves out truncated results from the statistical calculations. Although these results are removed from the statistical dataset, it is possible however to give a performance indication to truncated values.

For this, DUCARES has developed a Z-Score Arrow Ranges (ZSAR) statistical method. The ZSAR method provides a z-score range between the lowest possible z-score (result = 0) and the highest possible z-score (< result).

The information provided by the ZSAR method gives the participant a good indication if the values of the truncated results are in the range of $|z| = 2$ and $|z| = 3$. If necessary, the participant can take corrective actions.

As example, the PT results of the parameter Cadmium (Cd) in maize oil were studied. The ZSAR method was compared with the draft ISO standard 13528 concerning truncated results. The dataset contained three labs that provided truncated results.

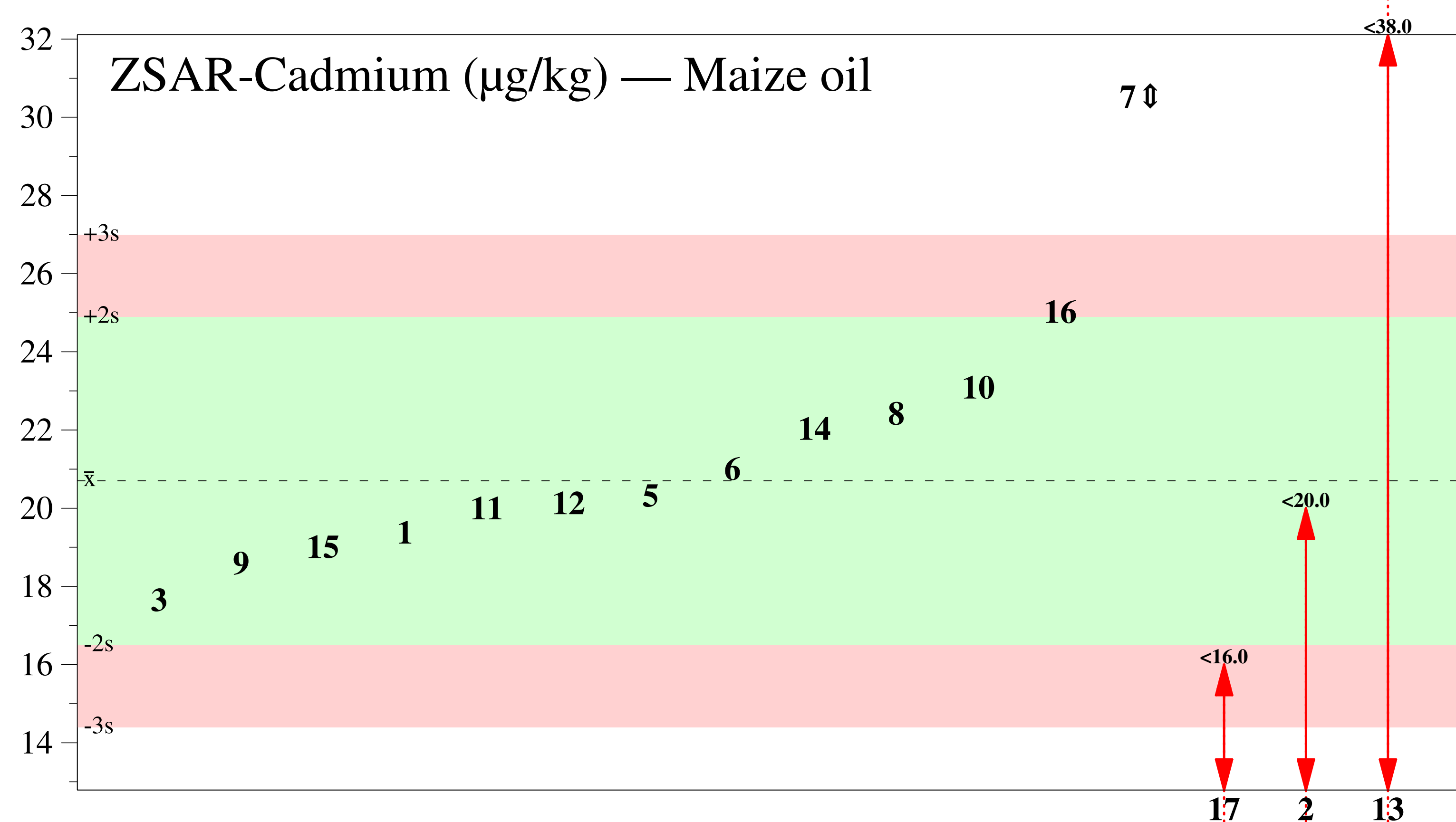


Figure 1: Cadmium in maize oil, a graphical presentation of the ZSAR method.

Lab	Result	ZSAR	ISO 13528 removal '<' sign	ISO 13528 50% limit value
1	19.4	-0.6	-0.4	-0.6
2	<20.0	-9.9 : -0.3	-0.1	-5.1
3	17.6	-1.5	-1.2	-1.4
5	20.3	-0.2	0	-0.1
6	21	0.1	0.3	0.2
7	30.5†	4.7	4.4	4.8
8	22.4	0.8	0.9	0.9
9	18.6	-1.0	-0.8	-1.0
10	23.1	1.1	1.2	1.2
11	20	-0.3	-0.1	-0.3
12	20.1	-0.3	-0.1	-0.2
13	<38.0	-9.9 : 8.2	7.7	-0.8
14	22	0.6	0.7	0.7
15	19	-0.8	-0.6	-0.8
16	25	2.0	2.0	2.1
17	<16.0	-9.9 : -2.2	-1.9	-6.1

Table 1: Cadmium in maize oil, comparison of z-scores with ZSAR method and ISO13528 approaches. The † sign depicts that the result of lab 7 is an outlier.

Results and Discussion

The ZSAR results are shown graphically, with arrows in the distribution plot (Figure 1). The ZSAR method shows z-scores ranging from satisfactory to unsatisfactory. This gives participants the unique opportunity to evaluate their truncated results directly in a visual way.

In Table 1, a comparison of z-scores with the various methods is shown. The ISO 13528 methods give different z-scores for the three labs with truncated values.

Remarkable is that these ISO 13528 approaches provide contradictory results. In contrast, the ZSAR method shows that the z-score ranges between satisfactory and unsatisfactory for all three labs.

PT providers should therefore be aware that the z-scores of truncated results must be carefully studied when applying draft ISO 13528 methods. The ZSAR method is a good alternative for providing indicative z-scores for truncated values.

Conclusions

- In certain cases, the draft ISO 13528 approaches may result in distorted z-scores for truncated results.
- The ZSAR method is a good alternative for estimating the z-score ranges of truncated results.
- The ZSAR method may be an additional and valuable approach to be incorporated in the standard ISO 13528.