# MUSTY COMPOUNDS IN SORGHUM AND THEIR PERCEPTION BY A TRAINED PANEL

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## *INTRODUCTION*

Odor is an important quality parameter for grading grains in United States, especially those for export. Off-odors in grain, such as “musty” or “sour”, lead to a decrease in the product’s value. Some studies related different chemical compounds to musty odor in grain, such as: Geosmin, 2-Methylisoborneol or Methoxybenzene and its derivates (Jeleń *et al*. 2003, Seitz and Ram 2000). In the USDA Grain Inspection Handbook (U.S. Department of Agriculture, 2010) only three examples are provided for musty (“ground”, “insect” and “moldy”), but no references or chemical compounds are related to these examples. The USDA inspectors are responsible for making final determinations for all odors, and a consensus of experienced inspectors is used for samples containing marginal odors. Using standards and chemical references, the frequency of consensus evaluations may be reduced, and the consistency of odor examinations can improve.

## *OBJECTIVES*

The objectives of this project were: a) to determine volatile compounds present in musty sorghum, and b) to develop sensory references for musty odors in grain sorghum (also known as milo).

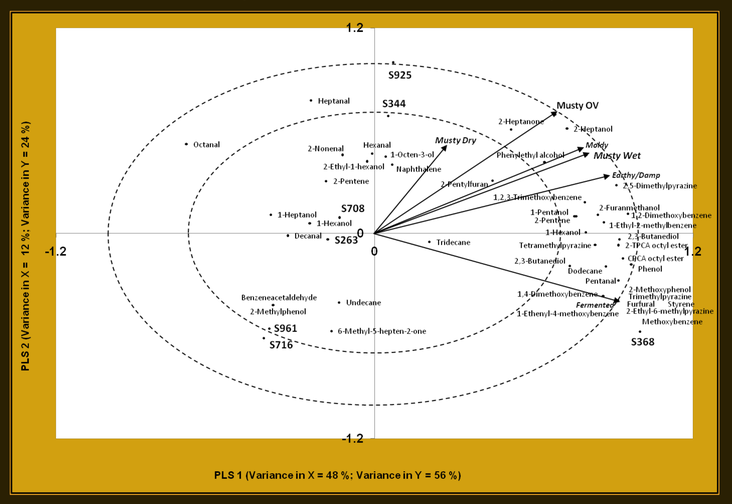
## *EXPERIMENTAL*

Sensory analysis of grain, and head space-solid phase microextraction-gas chromatography-mass spectrometry (HS-SPME-GC-MS) were performed in this study. Partial least square correlations (PLS) were done to study relationships between the sensory evaluations and the presence of volatile compounds in clean and musty sorghum. Some references were developed using chemical compounds spiked over clean grain to reproduce musty odors in the sorghum.

TABLE 1. Chemical compounds used to prepare musty references/standards for sorghum grain.

| Compound | Concentration (mg/kg) | Sensory attribute and intensity | | | |
|---|---|---|---|---|---|
| | | Musty overall | Musty, Dry | Musty, Wet | |
| | | | | Overall | Earthy/Damp |
| **Strips** | | | | | |
| 1,2-Dimethoxybenzene | 5000 | 3.5 | 0 | 3.5 | 0 |
| 1,2-Dimethoxybenzene | 10000 | 7.0 | 0 | 7.0 | 0 |
| 1,2,4-Trimethoxybenzene | 50000 | 4.0 | 4.0 | 0 | 0 |
| 1-Octen-3-ol | 5000 | 8.0 | 0 | 8.0 | 0 |
| 3-Octanone | 1000 | 7.5 | 0 | 7.5 | 0 |
| 3-Octanol | 5000 | 3.0 | 2.5 | 0 | 0 |
| Geosmine | 10 | 8.0 | 0 | 8.0 | 8.0 |
| Isopropyl quinoline | 10000 | 10.0 | 10.0 | 0 | 0 |
| **Sorghum grain** | | | | | |
| 1,2-Dimethoxybenzene | 100 | 5.5 | 1.5 | 3.0 | 0 |
| 1,2,4-Trimethoxybenzene | 100 | 4.0 | 4.0 | 0 | 0 |
| 1-Octen-3-ol | 100 | 4.5 | 0 | 4.0 | 2.0 |
| 3-Octanone | 100 | 4.5 | 4.5 | 0 | 0 |
| 3-Octanol | 100 | 4.0 | 3.0 | 1.5 | 0 |
| Geosmine | 0.1 | 4.5 | 0 | 4.5 | 2.0 |
| Isopropyl quinoline | 100 | 6.5 | 3.5 | 2.5 | 2.0 |
| **Combinations of compounds on sorghum grain** | | | | | |
| 1,2-Dimethoxybenzene + Geosmin | 25 + 0.025 (respectively) | 8.5 | 2.0 | 5.5 | 0 |
| 1,2-Dimethoxybenzene + Geosmin | 50 + 0.05 (respectively) | 9.5 | 2.0 | 8.0 | 0 |
| 1,2-Dimethoxybenzene + 1,2,4-Trimethoxybenzene | 25 + 25 (respectively) | 3.0 | 2.5 | 1.5 | 0 |
| 1,2-Dimethoxybenzene + 1,2,4-Trimethoxybenzene | 50 + 50 (respectively) | 4.0 | 3.0 | 1.5 | 0 |

FIGURE 1. PLS Regression map illustrating the relationship between instrumental data correlated with sensory data in some of the studied samples.




*Seven grain samples with complete sensory and instrumental aromatic profile performed: clean samples (**S961** and **S716**), “musty dry” samples (**S708** and **S263**) and “musty wet” samples (**S344**, **S925** and **S368**). Sensory parameters: indicated by arrows. ● Instrumental data: volatile compounds.*

## *RESULTS AND DISCUSSION*

Two groups of sorghum grain were differentiated: **“dry”** and **“wet” musty grain**. Musty sorghum with “wet” odor notes had other off-odor notes stated as: earthy/damp or moldy. The presence of these odor notes seemed to indicate the presence of different aromatic compounds when compared with “dry” musty grain samples. After sensory evaluation of the samples, volatile composition of the grain was determined. “Musty dry” characteristics in grain seemed to be related with compounds such as 1-octen-3-ol, hexanal, 1-hexanol, heptanal, 1-heptanol, etc (Figure 1). On the other hand, “musty wet” samples, which had other aromatic notes (e.g. earthy/damp, fermented or moldy) were related with methoxybenzenes or pyrazines.

Some compounds found in the musty sorghum were labeled as “musty” standards to use for development of sensory references. Clean grain spiked with **geosmin (0.1 mg/kg), 1,2-dimethoxybenzene (100 mg/kg), 3-octanone (100 mg/kg), or 1,2,4-trimethoxybenzene (100 mg/kg) appeared** to be the most likely candidates (individually or in combination) to reproduce the musty odor notes when added to clean grain.

A major finding was regardless of whether it is subdivided into wet or dry musty, a clear sensory descriptor defined as “musty” was relatively easy to recognize.

*Acknowledgments:*

*References*

•JELEŃ, H.H., MAJCHER, M., ZAWIRSKA-WOJTASIAK, R., WIEWÓROWSKA, and M., WĄSOWICZ, E. 2003. J. Agric. Food Chem. *51*, 7079-7085.
•SEITZ, L.M., and RAM, M.S. 2000. J. Agric. Food Chem. *48*, 4279-4289
•U.S. Department of Agriculture. 2010. Grain Inspection Handbook. http://www.gipsa.usda.gov/.

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