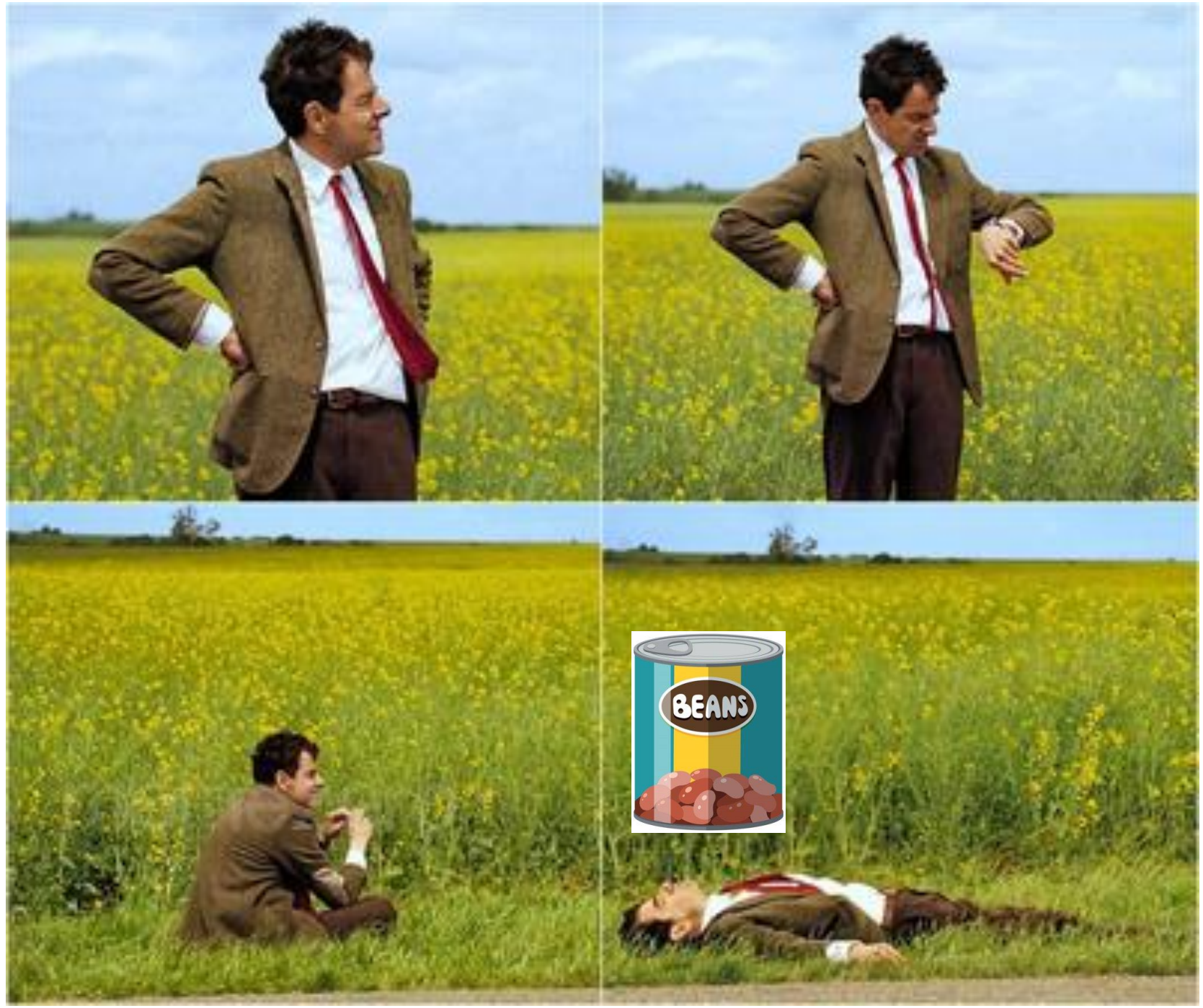
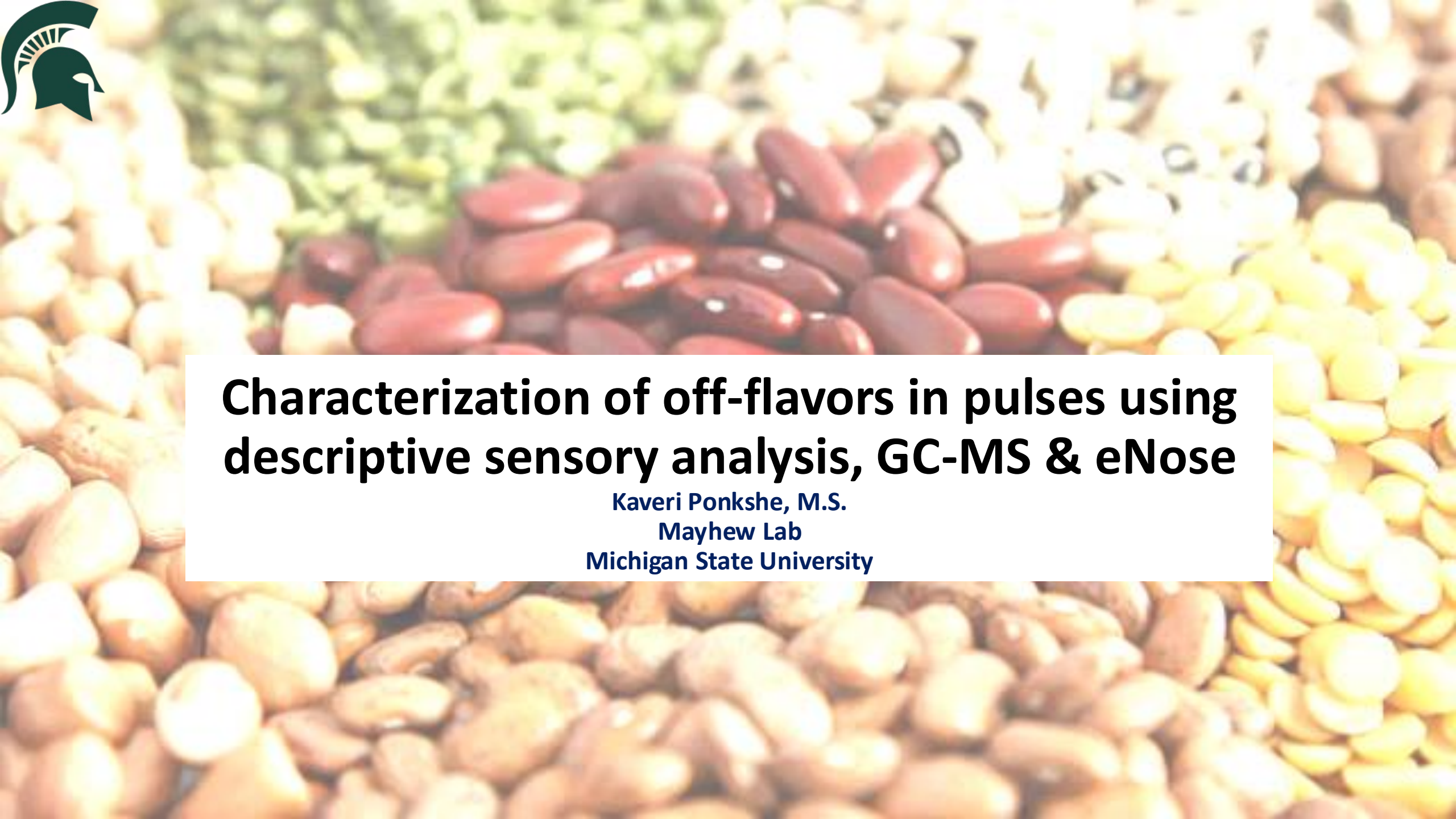

BEANS



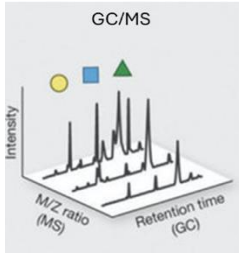
Characterization of off-flavors in pulses using descriptive sensory analysis, GC-MS & eNose

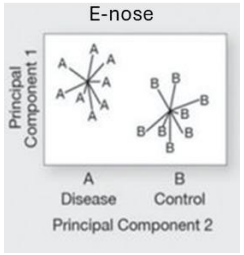
Kaveri Ponkshe, M.S.
Mayhew Lab
Michigan State University

Outline


Explore the motivation and barriers to incorporation of pulse ingredients

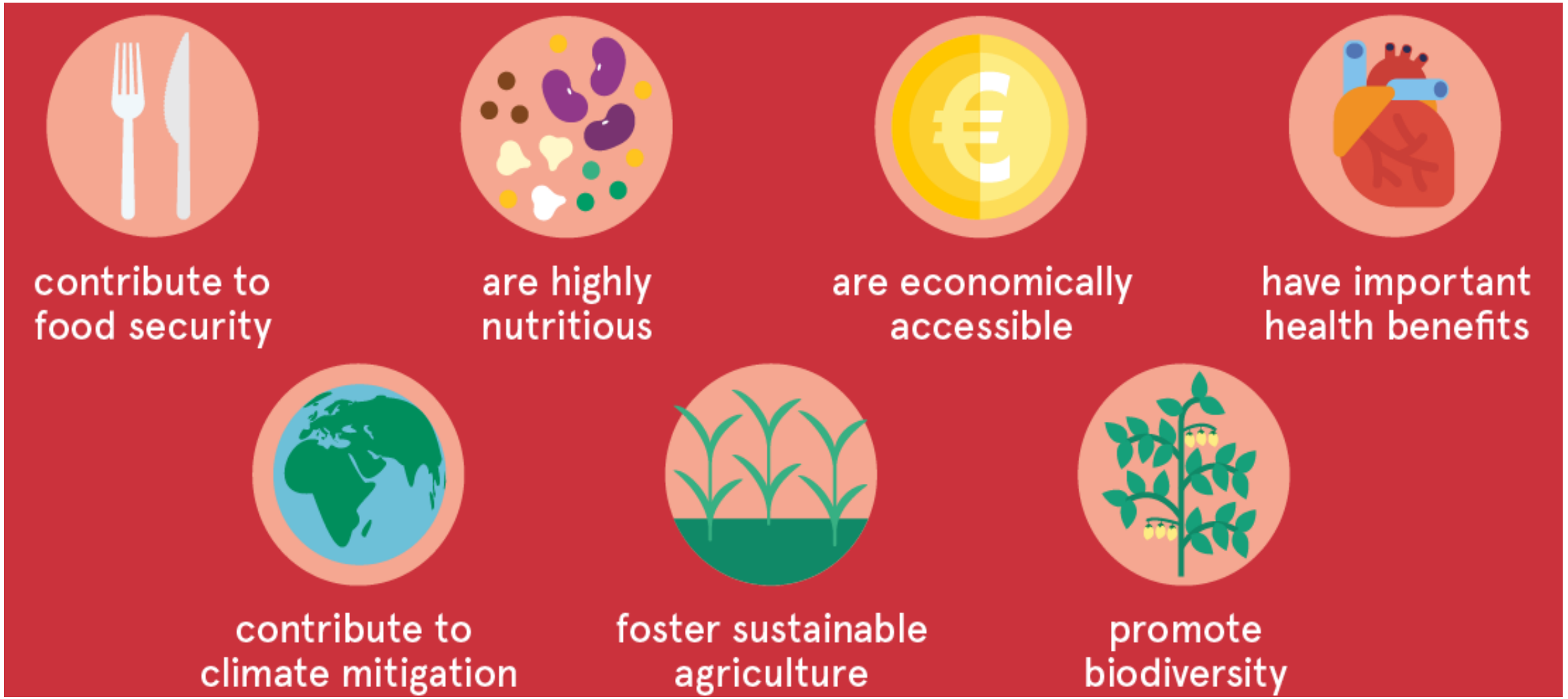
Analyze the effect of cultivar and processing on off-flavors using Descriptive analysis (DA)





Compare chemical predictors of off-flavors using GC-MS & eNose

What are the benefits of pulses ?



(Geil, et al., 1994) (Clune, Crossin, & Verghese, 2017)
https://www.eufic.org/en/newsroom/article/eufic-joins-forces-with-beans-is-how-to-help-tackle-climate-health-cost-of-living-crisis

27%

Reasons for low American pulse consumption

- Approximately 27% of adults consumed pulses lesser than Dietary Guidelines for Americans (DGA) recommendation: 1.5-cup per week in a 2000-calorie day diet.

1. Time consuming due to advanced planning
2. Lack of knowledge in cooking
3. Disliking the taste or texture

(Mitchell, et al., 2009)
(Garden-Robinson, J., & West, R. 2023)

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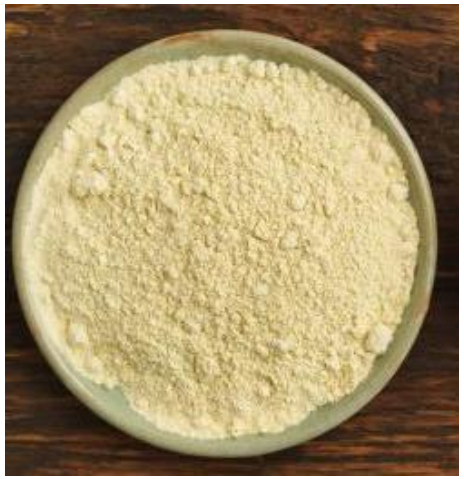
Opportunities



(Mitchell, et al., 2009)
(Garden-Robinson, J., & West, R. 2023)
(Vara-ubol, Chambers et al. 2004, Roland, Pouvreau et al. 2017)

Sensory challenges to incorporate pulse ingredients

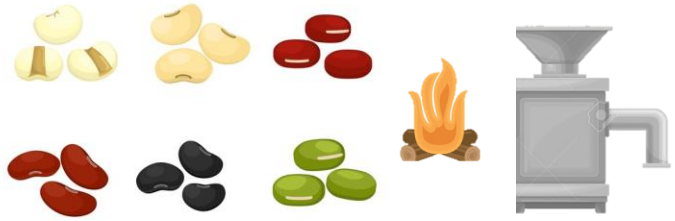
- Difficult to achieve satisfactory processing and sensory characteristics with pulse flours.
- **Beany-related flavors** found in pulses are described by consumers as **green, grassy, earthy, musty** and **bitter**.




(Sharan et al., 2020; Roland, Pouvreau, Curran, van de Velde, & de Kok, 2017; Bott & Chambers, 2006 ;Parker, 2015; Balagiannis, 2015)

Outline

Explore the motivation and barriers to incorporation of pulse ingredients



Analyze the effect of cultivar and processing on off-flavors using Descriptive analysis (DA)

Eight pulse cultivar

Otebo
(Samurai)

Navy
(Alpena)

Great northern
(Powderhorn)

White kidney
(WK-1601-1)

Manteca
(Y-1608-07)

Mayacoba
(Y-1802-9-1)

Cranberry
(CR-1801-2-2)

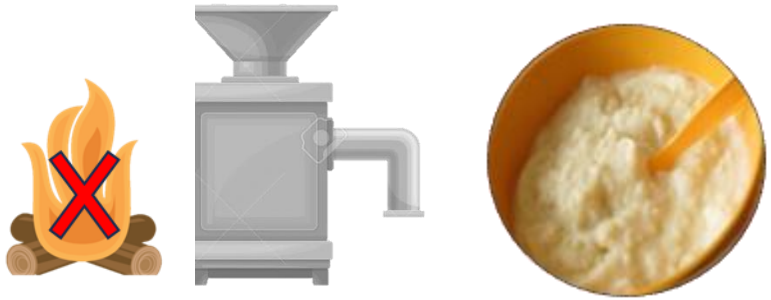
Kabuli chickpea
(Sierra)

Sample Preparation

Boiled pulses

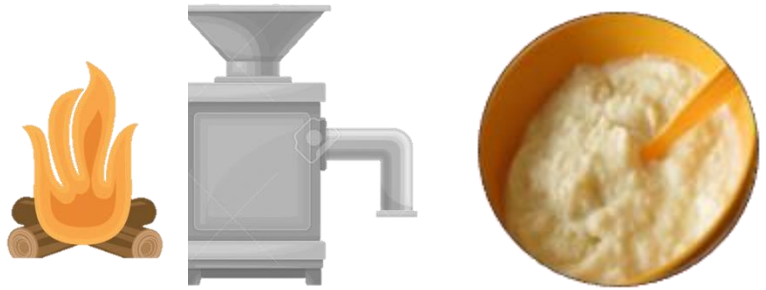
Pulses-> Soaking -> Boiling
Cook time (20-108 min)-> Boiled pulses

Non-roasted flour porridge



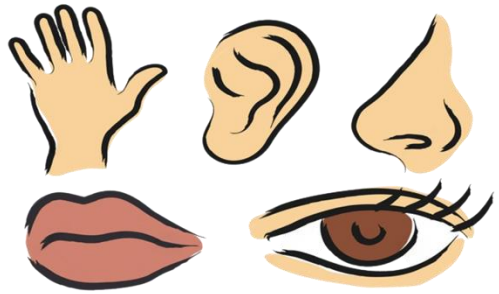
Dry pulses -> Milling
-> Non-roasted Porridge

Roasted flour porridge



Dry pulses -> Roasting -> Milling
-> Roasted Porridge

Descriptive Analysis, Training & Lexicon



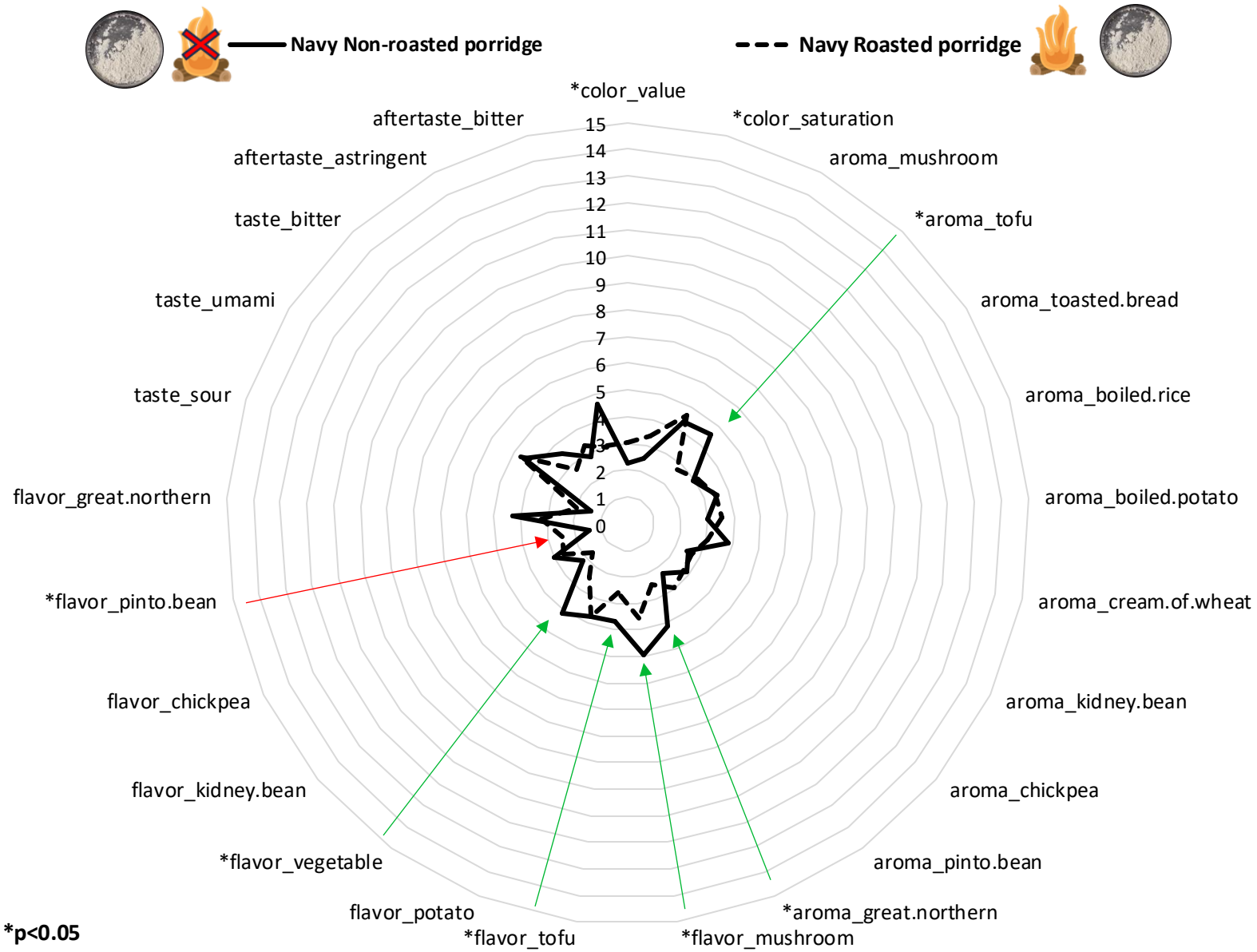
- 9 trained panelists
- 27 one-hour training sessions
- Line scale 0-15
- 24 samples; 2 replications

- Appearance
- Aroma
- Aroma-by-mouth/Flavor
- Taste
- Aftertaste

AROMA
Descriptor
Kidney bean/Beany
Chickpeas/Beany
Pinto beans/Beany
Great northern beans/Beany
Mushroom/Musty
Boiled Potato
Boiled rice/Starchy
Toasted bread
Tofu
Grainy

AROMA BY MOUTH
Descriptor
Kidney bean/Beany
Chickpeas/Beany
Pinto beans/Beany
Great northern beans/Beany
Mushroom/Musty
Boiled Potato
Tofu
Vegetable/Green

Roasting reduced known off-flavors but, increased beany flavor

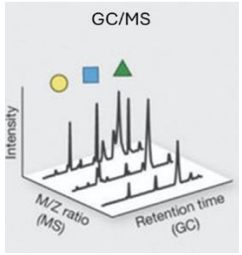


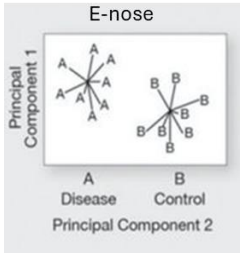
***p<0.05**

Outline

Explore the motivation and barriers to incorporation of pulse ingredients

Analyze the effect of processing and cultivar on off-flavors using Descriptive analysis (DA)





Compare chemical predictors of off-flavors using GC-MS & eNose

Targeted GC-MS Analysis

Boiled pulse

Pulse flour

Porridge

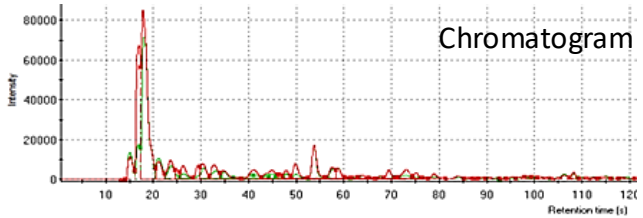
Many peaks

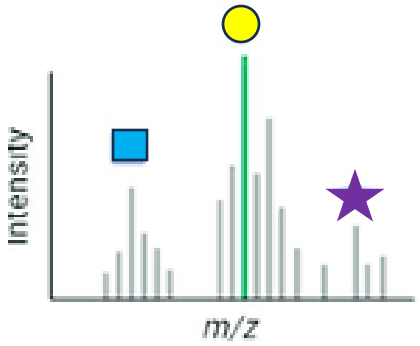
⬇

Uses authentic standards to select subset of peaks

⬇

Identity of peaks known





Chemical analytical based

Untargeted eNose Analysis

Pulse flour

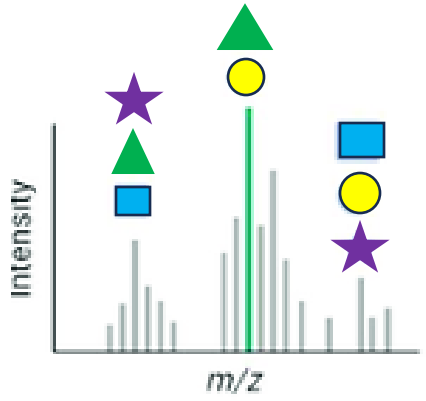
Many peaks

⬇

Uses PLS to select subset of peaks integrated with DA flavor ratings

⬇

Identity of peaks unknown



Pattern based

**predictive peaks associated to potential compounds*

Volatile markers of off-flavors in pulse flour using GC-MS

Beany?

Roasted bean flour

Non-roasted bean flour

Roasted bean flour

Boiled beans

Non-roasted bean flour

WK_RP
N_RP
Sulfur
Nitrogen
Alkane
CR_RP
CR_NRP
MY_BP
WK_BP
MN_RP
MY_NRP
Ketone
GN_RP
MY_RP
GN_BP
Aromatic
O_BP
N_BP
CHKP_BP
Alcohol
Terpenoid
MN_BP
O_RP
CR_BP
O_NRP
MN_NRP
GN_NRP
CHKP_RP
WK_NRP
Aldehyde
CHKP_NRP

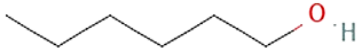
Dim2 (22.5%)

3
2
1
0
-1
-2
-3

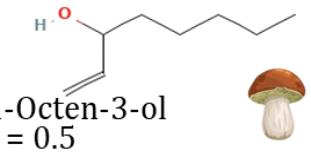
Dim1 (30.2%)

-2
0
2
4

Alcohols: green & musty flavor

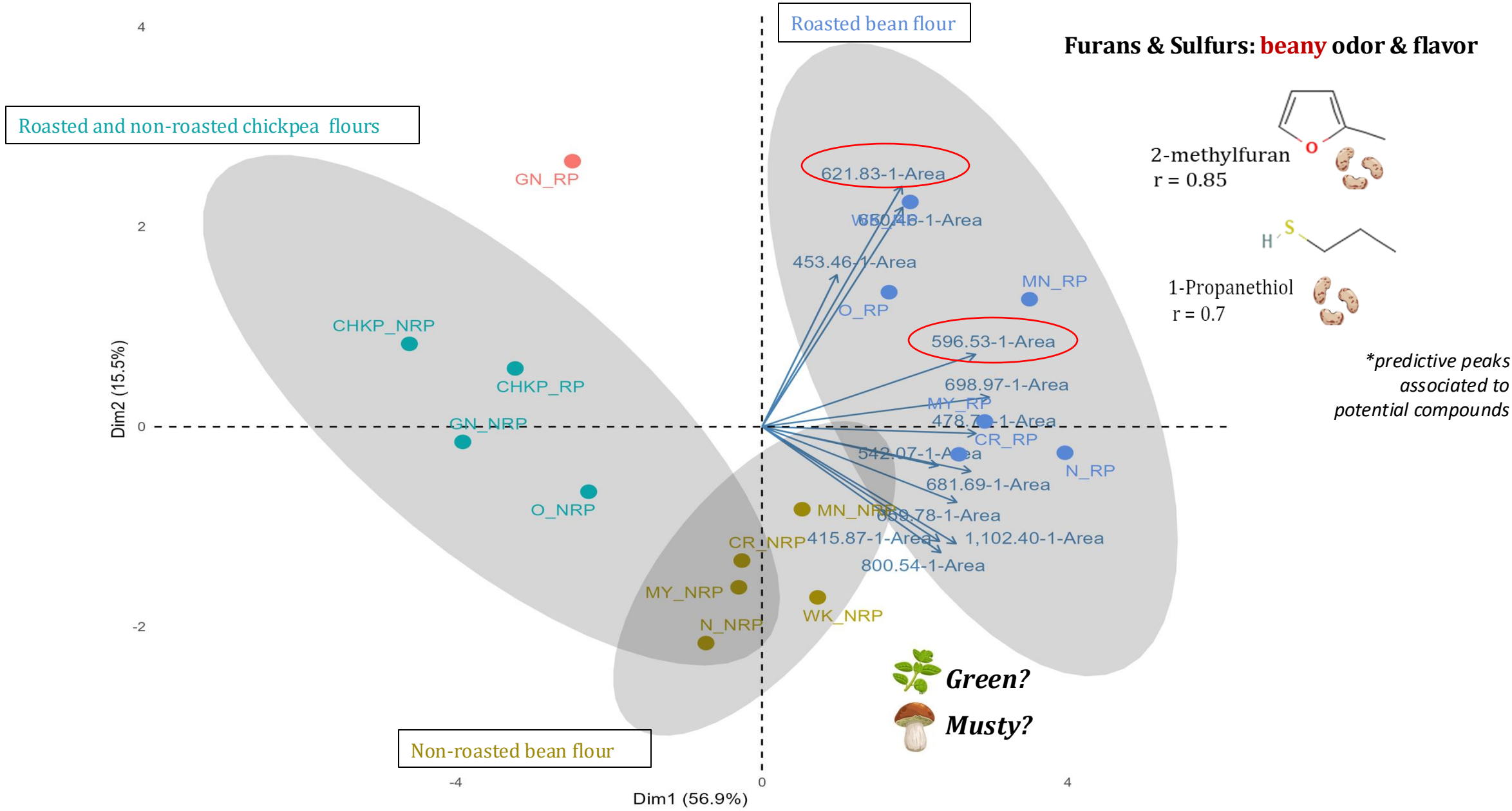


1-Hexanol
r = 0.6



1-Octen-3-ol
r = 0.5

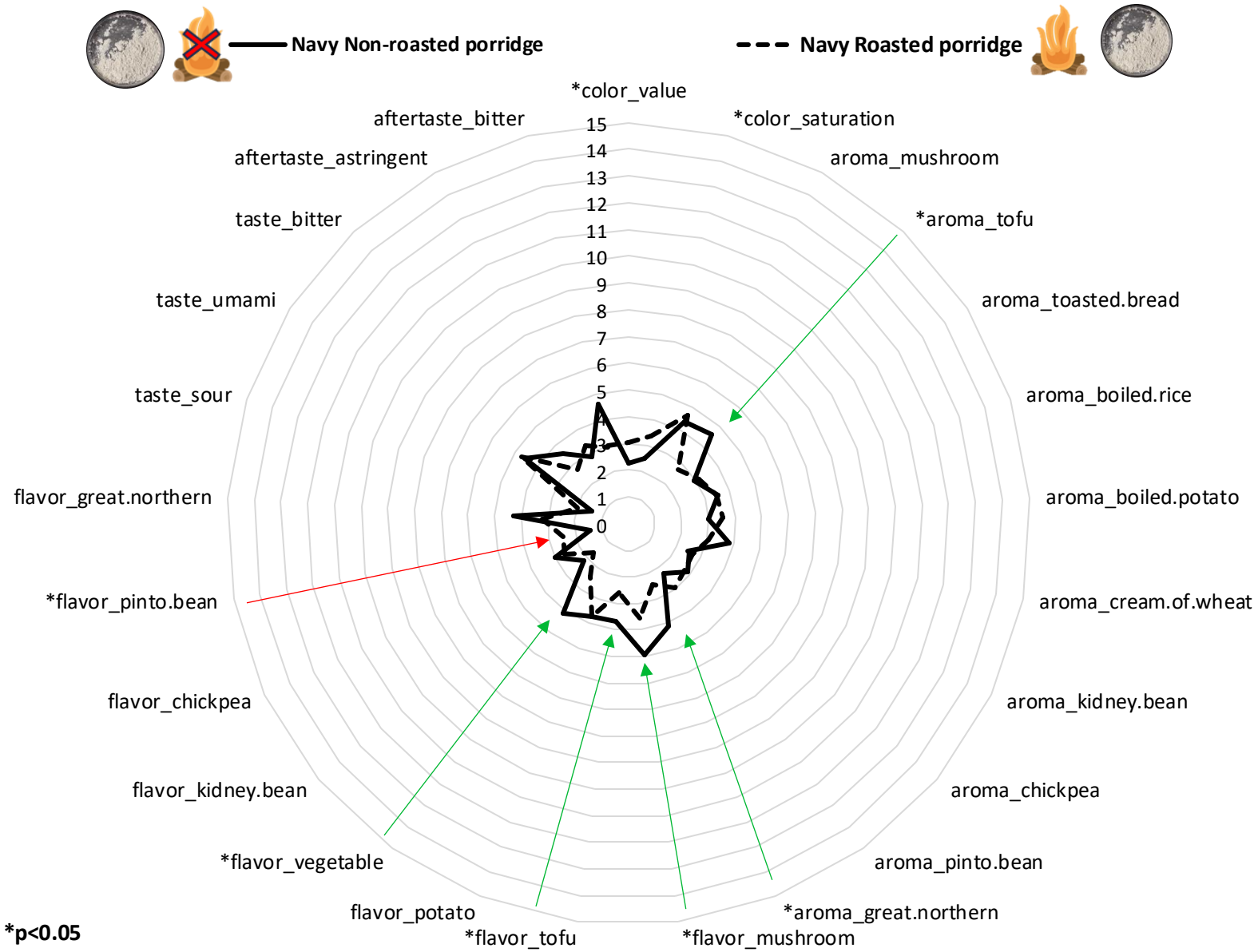
Beany volatile markers identified using eNose



Conclusion

What is the significance?

Roasting reduced known off-flavors but, increased beany flavor



*p<0.05

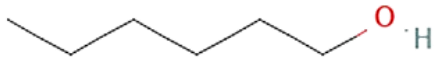
Targeted GC-MS Analysis

Boiled pulse

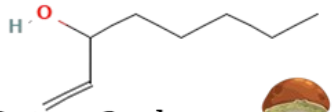
Pulse flour

Porridge

Alcohols: green & musty flavor



1-Hexanol
r = 0.6

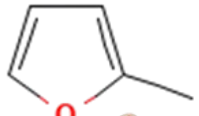


1-Octen-3-ol
r = 0.5

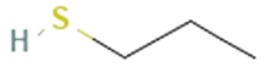
Untargeted eNose Analysis

Pulse flour

Furans & Sulfurs: beany odor & flavor



2-methylfuran
r = 0.85



1-Propanethiol
r = 0.7

Acknowledgements

- Co-authors: Aubrey DuBois[1], Randolph Beaudry[2], Sharon Hooper[3], Karen Cichy[3,4], and Emily J. Mayhew[1]

  [1]Department of Food Science and Human Nutrition, Michigan State University (MSU); [2]Department of Horticulture, MSU; [3]Department of Plant, Soil and Microbial Sciences, MSU; [4]USDA-ARS

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References

1. Geil, PB & Anderson, JW (1994) Nutrition and health implications of dry beans: a review. Journal of the American College of Nutrition 13, 549–558.
2. Clune, S., Crossin, E., & Verghese, K. (2017). Systematic review of greenhouse gas emissions for different fresh food categories. Journal of Cleaner Production, 140(2), 766–783.
3. Mitchell, D. C., Lawrence, F. R., Hartman, T. J., & Curran, J. M. (2009). Consumption of dry beans, peas, and lentils could improve diet quality in the US population. Journal of the American Dietetic Association, 109(5), 909–913. https://doi.org/10.1016/j.jada.2009.02.029
4. Garden-Robinson, J., & West, R. (2023). Increasing Pulse Foods in the Human Diet: A Qualitative Study. Medical Research Archives, 11(10). doi:10.18103/mra.v11i10.4630
5. VARA-UBOL, S. U. N. T. A. R. E. E., Chambers, E., & Chambers, D. H. (2004). Sensory Characteristics of Chemical Compounds Potentially Associated with Beany Aroma in Foods 1. *Journal of Sensory Studies*, *19*(1), 15-26.
6. Roland, W. S. U., Pouvreau, L. A. M., Curran, J., van de Velde, F., & de Kok, P. M. T. (2017). Flavor Aspects of Pulse Ingredients. Cereal Chemistry, 94(1), 58-65. https://doi.org/10.1094/CCHEM-06-16-0161-FI
7. Bott, L., & CHAMBERS IV, E. D. G. A. R. (2006). Sensory characteristics of combinations of chemicals potentially associated with beany aroma in foods. *Journal of sensory studies*, *21*(3), 308-321.
8. Parker, Jane. (2015). Thermal generation or aroma. 10.1016/B978-1-78242-103-0.00008-4.
9. Balagiannis, D. (2015). Predicting aroma formation with kinetic models. In J. K. Parker, S. Elmore, & L. Methven (Eds.), Flavour development, analysis and perception in food and beverages (1st ed., pp. 211–233). Elsevier.
10. Sharan, S., Zanghelini, G., Zotzel, J., Bonerz, D., Aschoff, J., Saint-Eve, A., & Maillard, M. N. (2021). Fava bean (Vicia faba L.) for food applications: From seed to ingredient processing and its effect on functional properties, antinutritional factors, flavor, and color. *Comprehensive Reviews in Food Science and Food Safety*, *20*(1), 401-428.
11. Asikin, Y., Kusumiyati, Shikanai, T., & Wada, K. (2018). Volatile aroma components and MS-based electronic nose profiles of dogfruit (Pithecellobium jiringa) and stink bean (Parkia speciosa). Journal of Advanced Research, 9, 79–85. https://doi.org/10.1016/j.jare.2017.11.003

Thank you!

Roasting had a significant impact on the flavors of the pulses