

Formulation of Energy and Fibre Rich Instant Mix for Idli and Dosa Preparation

Zainab Bagwan

¹Department of Food Science and Nutrition, SNDT College of Home Science, Pune - 411038, India Rethink Bio, Pune - 411021, India

Abstract

Cereals are staple foods consumed across India and are an important source of energy, protein and fibre. This research was conducted to formulate a convenient instant mix in which the conventional ingredients were partially replaced by semolina, oat flakes, sorghum (jowar) and flattened rice. The instant idliand dosa mix was developed to save time and effort in meal preparation needed by traditional indigenous methods. The developed mix, according to the calculated nutritional composition, was rich in energy, fibre, and protein. The mix was observed to have a high water absorption capacity because of the pre-gelatinization of starch in the grains by dry roasting and the high water-holding ability of the cereal proteins. Hence, the addition of more water was required to obtain the optimum consistency of batters for idli and dosa preparation. The water content was optimized to determine the instant-mix-to-water ratio to form batters. The instant mix-to-water ratios for preparing the idli and dosa batters were 1:4 and 1:10, respectively. Consequently, the developed mix has high water absorption ability, requiring more water to form batters of the required consistency.

Keywords: Instant Mix, Convenience, Energy-Fibre, Idli and Dosa, Water Absorption, Water Optimization

Introduction

Indigenous fermentation is a traditional process influenced by cultural practices where the fermentation of foods is aided primarily by naturally occurring microbes. This is done to obtain a unique flavour profile and increase the storage of foods (MaríaMartínez-Espinosa, 2020). The microorganisms actively involved in the fermentation process, produce enzymes capable of breaking down complex proteins, carbohydrates and fats into simpler forms aiding in better absorption (Siddiqui et al., 2023). A change in texture is one of the desired outputs of fermentation. Additionally, the carbon dioxide released during fermentation is pivotal for enhancing the texture of the final fermented product. It helps in leavening and creating lighter, airier and softer products (Sawant et al., 2025). Despite having a long history of consumption, most traditional fermented foods in India have a short shelf-life. These foods are prone to spoilage by toxins from bacteria and moulds, often due to uncontrolled fermentation processes (Chaudhary et al., 2018). The majority of these products are unplanned and produced on a small scale with limited knowledge of the microbiota of these products (Prarthana et al., 2017). Maintaining high hygiene standards and ensuring aseptic conditions are requirements that pose significant challenges in



traditional fermentation processes (Barooah et al., 2020). Hence controlled fermentation is necessary to obtain properties such as desirable flavour and acidity levels in the product (Sathe&Mandal, 2016).

Idliand dosa are rice and legume-based fermented foods that originate from the Indian Subcontinent and have been staple foods of South Indian cuisine for many years. Idliis soft and spongy while dosa is thin semisoft to crisp and has a mild sour taste as a result of fermentation (Tamang, 2020 andSathe&Mandal, 2016). Today, idli and dosa not only are favourites across India but also have gained popularity worldwide (Mathew, 2020). The conventional preparation of these food products requires a long fermentation time to achieve the desired level of sensory acceptability (Harichandana et al., 2020). Furthermore, batters have a limited shelf life because of their elevated moisture content and active fermentation process (Prarthana et al., 2017). This has led to the introduction of convenient ready-to-cook idli batters in the Indian market. However, addressing the inherent challenges related to the texture and packaging associated with these convenient batters is important (Regubalan&Ananthanarayan, 2018).

Convenience food has become popular in India as it not only saves time and energy but also has several options and can be used in emergencies (READY TO HEAT & EAT FOODS, n.d.). According to a recent report, the instant breakfast segment is gaining momentum, as companies continue to market a variety of time-saving instant mixes inspired by traditional Indian recipes (Ready to Eat (RTE) and Convenience Food, n.d.). However, despite breakfast being considered an essential meal of the day, a majority of people in the metro cities were reported to consume breakfast with inadequate nutrients and calories according to Kellogg's report about the consumption of a nutritionally inadequate breakfast by the urban population in India (Nutritional Adequacy of Breakfast: Its Relationship to Daily Nutrient Intake among Children, Adolescents and Adults, n.d.). However, it has been emphasized that a healthy dietary pattern consists of nutrient-dense food sources consumed in appropriate amounts, which is crucial for maintaining health and preventing disease at all stages of life (Espinosa-Salas & Gonzalez-Arias, 2025). This might be related to the challenge of regulating the portion size and nutrient intake from home-cooked meals.

Semolina is a wheat-based ingredient made by milling and sifting durum wheat to the desired particle size and uniformity (Kill & Turnbull, 2000). It has been commonly used in pasta production and is a versatile ingredient with both traditional and modern applications in the food industry. It is rich in protein and carbohydrates (Suryawanshi et al., 2023).

Sorghum is a cereal grain that is a source of carbohydrates, resistant starch, proteins, and lipids. It is usually used to prepare bread and porridge in Indian cuisine (Xiong et al., 2019).

Oat is a potential functional ingredient used in food formulations, because of properties such as waxylike starch gelatinization, high β -glucan content lipid-lowering and glucose-stabilizing effects (Ahmed &Urooj, 2022).

Fattened or flaked rice is made by soaking, roasting and flaking paddy. It is widely consumed as a breakfast cereal and a snack option, offering a good source of fibre and calories (Puffed and Flaked Rice Processing, n.d. and Puffed/Flaked Rice, n.d.).

Black gram dal is a good source of protein and is consumed in the form of *dhal* or is utilized in the preparation of various fermented dishes, such as *idli, dosa* and *wada* in India.



E-ISSN: 2582-2160 • Website: www.ijfmr.com • Email: editor@ijfmr.com

Fenugreek seed has high protein and fibre content and is commonly used as a flavouring ingredient in several traditional foods(Banik et al., 2024).

This research focuses on developing a healthier and quicker version of traditional South Indian foods, idli and dosa. Instead of using only rice and black gram dal, a mix of nutritious ingredients such as semolina, sorghum (jowar), flattened rice, and oat flakes was used. These ingredients are rich in fibre and energy, which can support better digestion and help manage blood sugar levels. The aim was also to skip the usual overnight fermentation step, making it faster and easier to prepare. This study looks at how these changes affect the quality of the final product by optimizing the cooking process and aiming to develop a convenient and nutritious alternative while maintaining traditional characteristics.

Materials and Methods Raw Materials

Semolina, oat flakes, sorghum (jowar), flattened rice; black gram dal, fenugreek seeds, iodized salt, sodium bicarbonate, and curd were procured from the local market in Pune, Maharashtra and stored under ambient conditions.

Preparation of the Instant Mix

Semolina, oat flakes, sorghum, flattened rice, and black gram dal were lightly roasted separately on the pan and set aside to cool. Once cooled, they were ground together. Fenugreek seeds were also ground and mixed with sodium bicarbonate and salt. All the ingredients were combined to obtain the instant mix, which was stored in a polypropylene stand-up pouch at room temperature (28–30°C).

Ingredient	Amount (g)
Semolina	60
Sorghum (Jowar)	40
Oat flakes	40
Flattened rice	40
Black gram dal	20
Fenugreek seeds	5
Baking soda	5
Iodized Salt	2

Table 1: Formulation of the Instant Mix

Preparation of Idli from the Instant Mix

Idlis were prepared by mixing instant mix with curd at a ratio of 2:1 and adding water to form a batter. The batter was allowed to rest for 15 minutes, followed by steaming for 20 minutes.

Preparation of Dosa from Instant Mix

Dosa was prepared by combining the instant mix with curd at a ratio of 2:1 and adding water to form a batter. The batter was allowed to rest for 15 minutes, followed by cooking on a pan.



Analysis

Optimization of Water

To optimize the water content utilized to reconstitute the instant mix for the preparation of idli and dosa, different instant mix-to-water ratios were tested while keeping the instant mix-to-curd ratio constant. For dosa, the ratios of instant mix-to-water, 1:2, 1:5 and 1:10 were tested and for idli, 1:2, 1:4, and 1:6 ratios were tested. This was done to understand the amount of water required to make the final products and their impact on their texture.

Nutrition Composition

The nutritional composition of the instant mix was calculated on the basis of data extracted from the National Institute of Nutrition (NIN - 2017) and the U.S. Department of Agriculture (USDA) FoodData Central portal. The moisture content was evaluated by the process described by Shende et al. (2024).

Results and discussion

The instant mix absorbed more water while resting. While reconstituting the instant mix with water to obtain a batter, the mix absorbs water and swells, improving consistency and giving body to the product (Gunalan&Sneha A, 2018). This high water absorption capacity is determined by the presence of proteins, fibre and starch in the ingredients (Gunalan&Sneha A, 2018 and E Eswari, 2021). The high hygroscopicity may be related to the dry roasting process leading to the pregelatinization of starch present in the grains, resulting in increased swelling during fermentation (E Eswari, 2021).

The addition of ingredients such as semolina, flattened rice and sorghum plays a significant role in the high water absorption of the instant mix. Semolina has a high water-holding capacity related to the interaction of its gluten proteins with water, trapping water when hydrated (Suryawanshi et al., 2023). Asha et al. (2007) reported that flaked rice flour increased the viscosity of the black gram batter due to its high water-holding capacity. Roasted sorghum flour takes more time for hydration owing to the high water-holding capacity of its protein (Mahajan& Gupta, 2015). Oat flakes are pregelatinised and thin, allowing the starch to absorb more water and swell (Decker et al., 2014).

In dosa preparation, the spreadability increased with increasing water addition, whereas less water made the batter sticky and dense. The instant mix-to-water ratio of 1:2 produced a thick batter, reducing the spreadability, whereas the ratio of 1:5 slightly increased the spreadability, resulting in a pancake-like dosa. However, the instant mix-to-water ratio of 1:10 resulted in a standard thin and crispy dosa. The instant mix developed from dry roasted amaranth grain required more water for the forming the batter, which is attributed to the increased water absorption capacity of the grains (Gunalan&Sneha A, 2018).

For idli preparation, ratios of instant mix-to-water of 1:2 and 1:6 resulted in dense and sticky, idlis respectively. While a ratio of instant mix-to-water of 1:4 was suitable for idlis. Ohariya et al. (2017) reported that more water in the formulation results in excess stickiness to idli prepared from soy–kodo instant idli mix.

Nutritional Composition



E-ISSN: 2582-2160 • Website: www.ijfmr.com • Email: editor@ijfmr.com

The moisture content of the instant mix was 5%. The moisture content in the instant mix was lower than the acceptable limit for the shelf life stability of dry products, preventing microbial growth. The developed instant mix is high in energy, is a good source of protein, is low in fat and rich in fibre. The addition of semolina as the primary ingredient enhanced the protein and carbohydrate contents of the instant mix. Research has indicated that semolina idli mixes have a greater protein content than rice idli mixes (Bishnoi et al., 2015). Although sorghum is not widely used in the formulation of convenience foods, it has the potential to improve the functionality and quality of food products (Khoddami et al., 2023). In multigrain idli, the inclusion of sorghum has been shown to increase the protein, fat, fibre, calcium, and iron contents of the product (Adsare et al., 2022). Oat is a popular cereal recognized for its functional and nutritional properties. The utilization of oats in the preparation of instant idli and instant dosa batter mixes positively impacts the nutritional value by increasing the fibre and mineral contents and increasing the shelf life of instant dosa batter mix and instant idli respectively (Mehta & Jood, 2018 andJeba et al., 2018). Fenugreek seeds have been used as flavouring agents in traditional foods and as an ingredient in ready-to-cook and ready-to-eat modern food products (Banik et al., 2024). Fenugreek seeds are naturally high in protein and soluble dietary fibres hence; the incorporation of fenugreek seeds in food products contributes to increasing protein and dietary fibre contents (Khorshidian et al., 2016). The addition of fenugreek seed flour to semolina idli has been reported to increase protein, dietary fibre, and iron and calcium contents while simultaneously decreasing moisture, fat, carbohydrate and energy contents (Pooja&Dubey P, 2012). The nutritional composition of the instant mix is stated in Table 2.

Nutrient	Composition per 100 g
Moisture (%)	5.00
Energy (kcal)	343
Protein (g)	12.23
Total Carbohydrates (g)	66.45
Fibre (g)	9.866
Total Fat (g)	2.228
Calcium (mg)	68.618

Table 2: Nutritional Composition of Instant Mix per 100 g

Conclusion

The developed idli and dosa instant mix was rich in energy, fibre and protein. Proteins and fibres contributed to increased water absorption by the instant mix. Therefore, the water content was optimized. The optimization of the water content revealed that different water levels are required for idli and dosa preparation from the instant mix depending on the final texture desired. For the preparation of idlis and dosas from the instant mix, the ratios of mix-to-water required were 1:4 and 1:10, respectively. Further sensory studies can be performed to assess the overall acceptability of the final products prepared from the instant mix.

Appendix

- 1. Heat-Ready Eat Foods **pdf in msc2 FPD folder** Desikan, N. (Ed.). (n.d.). *READY TO HEAT & EAT FOODS*. Ministry of Consumer Affairs. <u>https://consumeraffairs.nic.in/sites/default/files/file-uploads/comparative-test-by-consumers-association-of-india/Heat-Ready.pdf</u>
- 2. RTE_report**pdf in msc2 FPDfolder** *Ready to Eat (RTE) and Convenience Food*. (n.d.). Sathguru Management Consultants. <u>https://www.sathguru.com/news/wp-</u> <u>content/uploads/2018/02/RTE_report.pdf</u>
- 3. (India-Breakfast-Habits-Study-Factsheet pdf in msc2 FPD folder) Nutritional Adequacy of Breakfast: Its relationship to daily nutrient intake among children, adolescents and adults. (n.d.). Kellogg's.

https://www.kelloggs.in/content/dam/Asia/kelloggs_in/en_IN/images/hcp/pdf/resourcesPDF/India-Breakfast-Habits-Study-Factsheet.pdf

- 4. **PUFFED AND FLAKED RICE 1 pdf** *-Puffed and Flaked Rice Processing*. (n.d.). Indian Institute of Food Processing Technology, Ministry of Food Processing Industries, Govt. of India. https://niftem.ac.in/newsite/pmfme/wp-content/uploads/2022/07/Rice-based-product-Process-<u>PPT.pdf</u>
- 5. PUFFED AND FLAKED RICE 2 pdf *Puffed/Flaked Rice*. (n.d.). [Model Detailed Project Report]. Indian Institute of Food Processing Technology (IIFPT), Ministry of Food Processing Industries, Government of India.
- 6. Longvah, T., Ananthan, R., Bhaskarachary, K., &Venkaiah, K. (2017). *Indian Food Composition Tables*. <u>www.ninindia.org</u>;
- 7. U.S. Department of Agriculture (USDA) Food Data Central, <u>https://fdc.nal.usda.gov/</u>

Conflict of Interest

I wish to confirm that there are no known competing interests associated with this publication.

Acknowledgements

This research originates from my college project, and I would like to express my sincere appreciation to the Department of Food Science and Nutrition, SNDT College of Home Science, Pune, for their support. I would also like to thank Ms SunainaDeshmukh and Ms PiyushaKokate for their valuable contributions to this study during our time in college.

Author's Biography

ZainabBagwan is a food technologist working as a research and development associate. She specializes in new product development, currently focusing on alternative-protein and plant-based processes and products. You can find her on LinkedIn at <u>linkedin.com/in/zainab-bagwan/</u>

References

- Adsare, A., Shinde, E., Patil, A., &Gajmal, D. (2022). Development and quality evaluation of MultigrainsIdli. *The Pharma Innovation Journal*, *11*(11S), 725–728. <u>https://www.thepharmajournal.com/special-</u> issue?year=2022&vol=11&issue=11S&ArticleId=16712
- Ahmed, F., &Urooj, A. (2022). Nutritionally Important Starch Fractions and Sensory Acceptability of Oats Incorporated Pongal – A Traditional Indian Food. *Current Research in Nutrition and Food Science Journal*, 10(1), 206–212. <u>https://www.foodandnutritionjournal.org/volume10number1/nutritionally-important-starch-</u> fractions-and-sensory-acceptability-of-oats-incorporated-pongal-a-traditional-indian-food/
- Asha, M. R., Susheelamma, N. S., &Guha, M. (2007). Rheological properties of black gram (*Phaseolusmungo*) batter: characterisation of flour from native and modified rice and their effect on batter viscosity. *International Journal of Food Science & Technology*, 42(6), 669–677. https://doi.org/10.1111/j.1365-2621.2006.01459.x
- Banik, S., Mandal, S., Karmakar, I., Biswas, K., &Ghosal, S. (2024). Fenugreek seeds based functional foods: A review. *International Journal of Agriculture and Food Science*, 6(1), 53–57. <u>https://doi.org/10.33545/2664844X.2024.v6.i1a.167</u>
- Barooah, M., Bora, S. S., &Goswami, G. (2020). Ethnic Fermented Foods and Beverages of Assam. In J. P. Tamang (Ed.), *Ethnic Fermented Foods and Beverages of India: Science History and Culture* (pp. 85–104). Springer Singapore. <u>https://doi.org/10.1007/978-981-15-1486-9_3</u>
- Bishnoi, S., Khanna, N., Bishnoi, N., Tewari, A., Ghadwal, S., &Ahlawat, S. S. (2015). Development of Chicken Meat Powder Incorporated Instant Idli Mixes. *Journal of Animal Research*, 5(3), 527. <u>https://doi.org/10.5958/2277-940X.2015.00089.3</u>
- Chaudhary, A., Sharma, D. K., & Arora, A. (2018). Prospects of Indian traditional fermented food as functional foods. *The Indian Journal of Agricultural Sciences*, 88(10), 1496–1501. https://doi.org/10.56093/ijas.v88i10.83956
- Decker, E. A., Rose, D. J., & Stewart, D. (2014). Processing of oats and the impact of processing operations on nutrition and health benefits. *British Journal of Nutrition*, 112(S2), S58–S64. <u>https://doi.org/10.1017/S000711451400227X</u>
- 9. E Eswari. (2021). *Optimization and characterization anf functional instant Idli mix* [Master's thesis, ICAR-National Dairy Research Institute]. https://krishikosh.egranth.ac.in/handle/1/5810200500
- 10. Espinosa-Salas, S., & Gonzalez-Arias, M. (2025). Nutrition: Macronutrient Intake, Imbalances, and Interventions. In *StatPearls*. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK594226/
- Harichandana, P., W, J. S., Kumari, B. A., &Tejashree, M. (2020). Standardization of fermentation time for rice to blackgram. *International Journal of Chemical Studies*, 8(1), 2438– 2440. <u>https://doi.org/10.22271/chemi.2020.v8.i1ak.8631</u>
- 12. Gunalan, H., &Sneha A. (2018). Development of amaranth grain (Amaranthuscruentus) based instant Dosa mix and its quality characteristics. *International Journal of Food Science and Nutrition*, *3*(1), 06–11. https://doi.org/10.13140/RG.2.2.10483.27687



E-ISSN: 2582-2160 • Website: <u>www.ijfmr.com</u> • Email: editor@ijfmr.com

- Jeba, S. R., Karthikeyan, K., &Pushparani, D. (2018). Development of Instant Dosa Batter Mix with Enhanced Nutritive Value and its Storage Study. *FoodSci: Indian Journal of Research in Food Science and Nutrition*, 5(2), 70. <u>https://doi.org/10.15613/fijrfn/2018/v5i2/180857</u>
- 14. Khoddami, A., Messina, V., VadabalijaVenkata, K., Farahnaky, A., Blanchard, C. L., & Roberts, T. H. (2023). Sorghum in foods: Functionality and potential in innovative products. *Critical Reviews in Food Science and Nutrition*, 63(9), 1170–1186. https://doi.org/10.1080/10408398.2021.1960793
- Khorshidian, N., YousefiAsli, M., Arab, M., AdeliMirzaie, A., &Mortazavian, A. M. (2016). Fenugreek: Potential Applications as a Functional Food and Nutraceutical. *Nutrition and Food in Health and Disease*, 3(1), 5–16. <u>https://doi.org/10.18869/acadpub.nfsr.3.1.5</u>
- Kill, R. C., & Turnbull, K. (Eds.). (2000). Pasta and Semolina Technology (1st ed.). Blackwell Science. <u>https://doi.org/10.1002/9780470999370</u>
- Mahajan, H., & Gupta, M. (2015). Nutritional, functional and rheological properties of processed sorghum and ragi grains. *Cogent Food & Agriculture*, 1(1), 1109495. <u>https://doi.org/10.1080/23311932.2015.1109495</u>
- MaríaMartínez-Espinosa, R. (2020). Introductory Chapter: A Brief Overview on Fermentation and Challenges for the Next Future. In R. MaríaMartínez-Espinosa (Ed.), *New Advances on Fermentation Processes*. IntechOpen. <u>https://doi.org/10.5772/intechopen.89418</u>
- Mehta, B., &Jood, S. (2018). Organoleptic Acceptability, Nutritional Properties and Shelf Life of Oat Based Gluten Free Instant idli. *International Journal of Current Microbiology and Applied Sciences*, 7(03), 1777–1787. <u>https://doi.org/10.20546/ijcmas.2018.703.209</u>
- 20. Ohariya, P., Singh, A., & Rajput, L. P. S. (2017). Quality attributes of instant kodo- soy idli mix as affected by fermentation period. *International Journal of Chemical Studies*, *5*(4), 1611–1615. <u>https://www.chemijournal.com/archives/?year=2017&vol=5&issue=4&ArticleId=857&si=false</u>
- 21. Pooja, K., &Dubey P, R. (2012). EFFECT OF FENUGREEK SEEDS FLOUR BLENDING ON SENSORY AND CHEMICAL CHARACTERISTICS OF SEMOLINA IDLI. International Journal of Current Research and Review. <u>https://ijcrr.com/abstract.php?article_id=1541</u>
- 22. Prarthana, S. P., Bhatt, H. K., & Joshi, D. C. (2017). Non-Thermal Preservation of Idli Batter using Sonication. *International Journal of Current Microbiology and Applied Sciences*, 6(6), 709–719. <u>https://doi.org/10.20546/ijcmas.2017.606.083</u>
- Regubalan, B., &Ananthanarayan, L. (2018). Shelf life improvement of idli batter by addition of mustard essential oil as bio-preservative. *Journal of Food Science and Technology*, 55(9), 3417– 3426. <u>https://doi.org/10.1007/s13197-018-3247-2</u>
- 24. Sathe, G. B., &Mandal, S. (2016). Fermented products of India and its implication: A review. *Asian Journal of Dairy and Food Research*, *35*(1). <u>https://doi.org/10.18805/ajdfr.v35i1.9244</u>
- 25. Sawant, S. S., Park, H.-Y., Sim, E.-Y., Kim, H.-S., & Choi, H.-S. (2025). Microbial Fermentation in Food: Impact on Functional Properties and Nutritional Enhancement—A Review of Recent Developments. *Fermentation*, 11(1), 15. https://doi.org/10.3390/fermentation11010015
- 26. Shende, Y. H., Makne, S. S., Ramteke, K. S., Yadav, C. J., P. N., &Watkar, P. (2024). Development of RagiDosa Premix. *International Journal for Research in Applied Science and Engineering Technology*, 12(5), 2107–2115. <u>https://doi.org/10.22214/ijraset.2024.61999</u>



E-ISSN: 2582-2160 • Website: <u>www.ijfmr.com</u> • Email: editor@ijfmr.com

- Siddiqui, S. A., Erol, Z., Rugji, J., Taşçı, F., Kahraman, H. A., Toppi, V., Musa, L., Di Giacinto, G., Bahmid, N. A., Mehdizadeh, M., & Castro-Muñoz, R. (2023). An overview of fermentation in the food industry looking back from a new perspective. *Bioresources and Bioprocessing*, *10*(1), 85. <u>https://doi.org/10.1186/s40643-023-00702-y</u>
- 28. Surve, V. D., & G. Ramesh. (2018). Biochemical and Microbial Characterization of Kurdi: A Traditional Fermented Food of Maharashtra. *International Journal of Current Microbiology and Applied Sciences*, *5*, 687–704. http://www.ijcmas.com
- 29. Suryawanshi, H. V., Sadawarte, S. K., Joshi, A., &Nikkam, I. T. (2023). COMPARATIVE ANALYSIS OF PHYSICAL, FUNCTIONAL, AND NUTRITIONAL PROPERTIES OF EMMER WHEAT (Triticumdicoccum) AND COMMON WHEAT (Triticumaestivum) SEMOLINA. International Journal of Agriculture Sciences, 15(10), 12702–12708. https://bioinfopublication.org/pages/article.php?id=BIA0006314
- Tamang, J. P. (2020). History and Culture of Indian Ethnic Fermented Foods and Beverages. In J. P. Tamang (Ed.), *Ethnic Fermented Foods and Beverages of India: Science History and Culture* (pp. 1–40). Springer Singapore. <u>https://doi.org/10.1007/978-981-15-1486-9</u>
- 31. Xiong, Y., Zhang, P., Warner, R. D., & Fang, Z. (2019). Sorghum Grain: From Genotype, Nutrition, and Phenolic Profile to Its Health Benefits and Food Applications. *Comprehensive Reviews in Food Science and Food Safety*, 18(6), 2025–2046. <u>https://doi.org/10.1111/1541-4337.12506</u>