# Impact of Ultrasonication on Physicochemical Properties and Digestibility of Sorghum Starch

**Zhihong Wang, Philipus Pangloli, Vermont Dia**

Department of Food Science, The University of Tennessee, 2510 River Drive, Knoxville, TN 37996-4591

## Introduction

Sorghum, a highly nutritious grain, is usually not considered as a main staple in many families because it is not as easy to be digested as other grains such as rice or maize.[1] But recent studies of ultrasonication shed a light on potential utilization of this world's fifth important cereal other than being raw material source of biofuel or liquor.[2] Ultrasonication is an innovative and environment-friendly food processing technique that has its commercially large-scale usage potential as it may lead to a higher yield, faster rate therefore less use of energy.[3]

The objectives of this study were to determine the effect of ultrasonication on the physicochemical properties and in vitro digestibility of sorghum starch. We hypothesized that ultrasonication would lead to changes in starch properties leading to improved starch digestibility. The results might provide the background for further research to broaden the practical usage of sonicated sorghum in foods.

## Materials & Methods

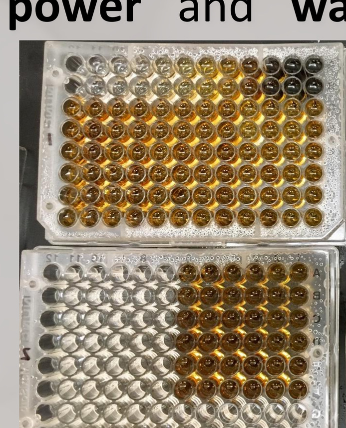
Two varieties of sorghum were used, namely **DG-765** and **DK-54-00.** Each variety was divided into two parts: one control unsonicated samples and one sonicated samples at 40% amplitude for 10 min. Each sample treatment was done in three independent replicates.

◆All samples were observed under **phase-contrast microscope** and **polarizing microscope**, pictures saved in duplicate.

◆**Differential Scanning Calorimetry (DSC)** heating from 20 to 100°C in nitrogen atmosphere was used to determine: **the onset of gelatinization**, **peak temperature**, **end of gelatinization temperature** and **gelatinization enthalpy**.

◆Determination of **solubility**, **swelling power** and **water retention capacity**.

◆**In vitro digestibility** of starch was tested using α-amylase and amylo-glucosidase from 0 to 120 min. of digestion. The **DNS** (3,5-Dinitrosalicylic acid) method was used, And the absorbance was read at 575nm.



◆**Statistical Analysis**: Each experiment was performed in three trials and data were analyzed using SAS version 9.4 and significance reported at P < 0.05 as separated by Tukey test

## Results

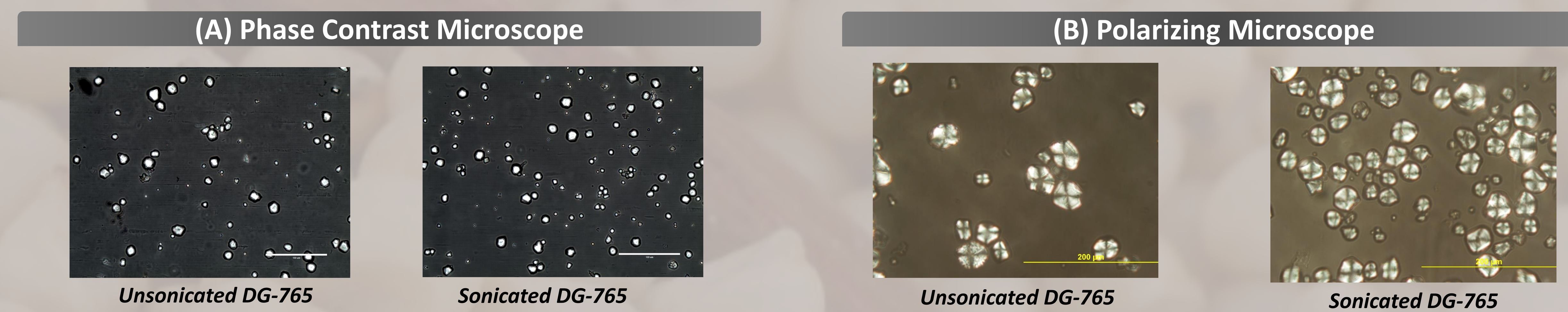



Figure 1. Microscopic images of sorghum starch. There was no apparent effect of ultrasonication on the morphology of sorghum starch granules as seen under phase contrast microscopy (A) and polarizing microscope (B).

### Thermal Properties

Table 1. Ultrasonication did not affect the thermal properties of sorghum starch

| *DG-765* | Onset gelatinization (℃) | Peak Temperature (℃) | End of gelatinization (℃) | Enthalpy of gelatinization (J/g) |
|---|---|---|---|---|
| Unsonicated | 66.00 ± 0.81 | 69.65 ± 0.15 | 92.52 ± 0.61 | 3.66 ± 0.08 |
| Sonicated | 65.53 ± 0.21 | 69.50 ± 0.32 | 91.70 ± 1.21 | 3.71 ± 0.09 |

| *DK-54-00* | Onset gelatinization (℃) | Peak Temperature (℃) | End of gelatinization (℃) | Enthalpy of gelatinization (J/g) |
|---|---|---|---|---|
| Unsonicated | 67.05 ± 0.16 | 71.14 ± 0.06 | 91.48 ± 0.25 | 3.49 ± 0.13 |
| Sonicated | 66.76 ± 0.03 | 71.10 ± 0.28 | 91.09 ± 0.47 | 3.17 ± 0.60 |

### Digestibility Test

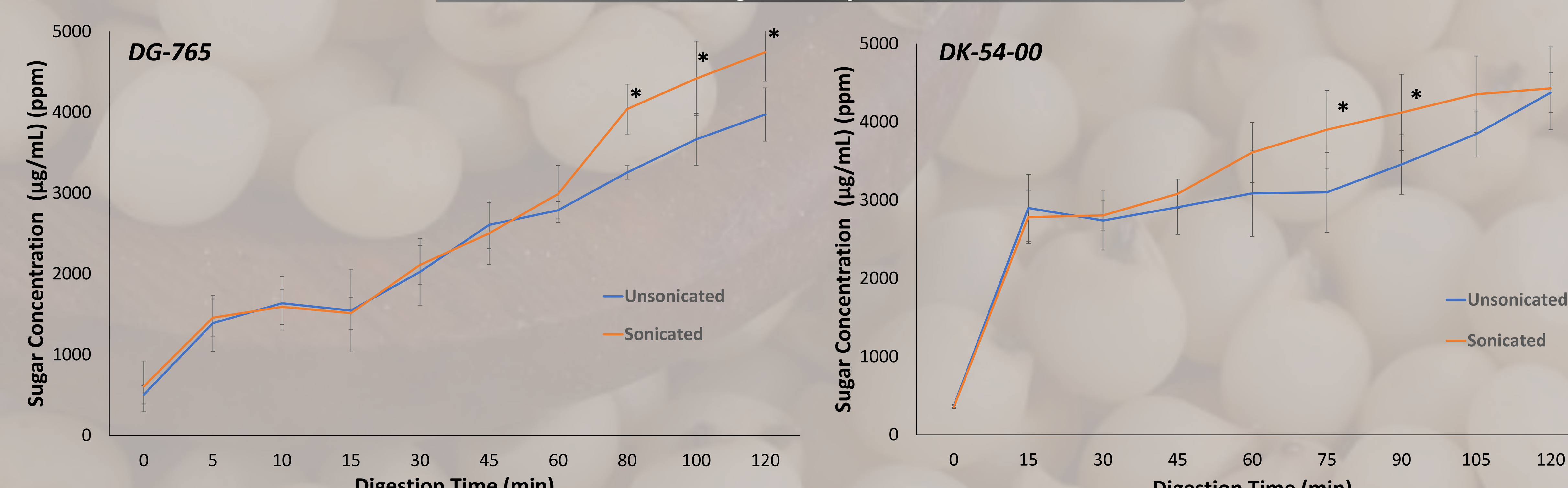



Figure 2. Ultrasonication improved in vitro digestibility of sorghum starch. The asterisk (*) indicates significant improvement in digestibility after ultrasonication at P < 0.05.

### Solubility Results, Swelling Power, and Water Retention Capacity

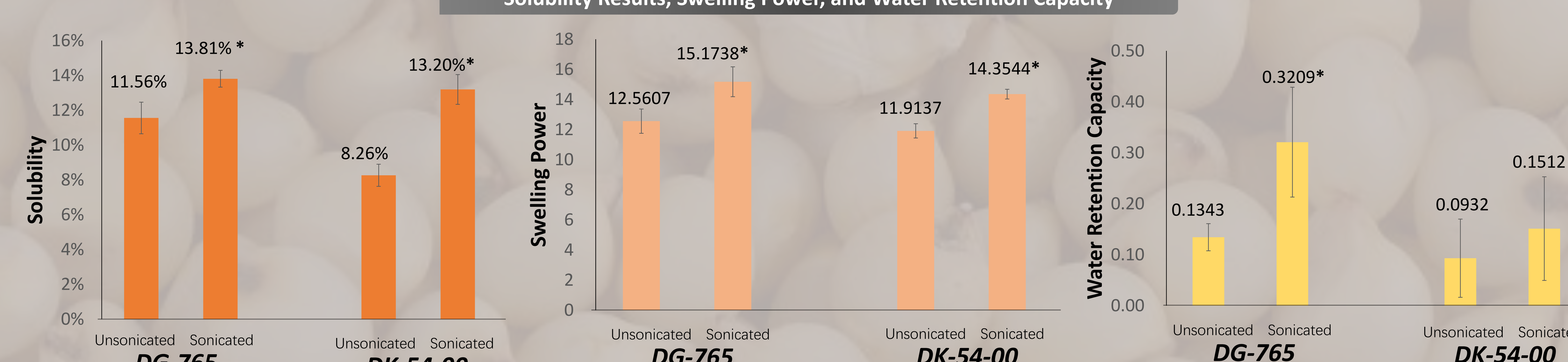



Figure 3. Ultrasonication improved the solubility, swelling power and water retention of sorghum starch. The asterisk (*) indicates significant improvement in properties after ultrasonication at P < 0.05.

## Conclusion

◆Sonication did not affect the morphology and thermal properties of sorghum starch

◆Sonication improved the digestibility of sorghum starch

◆Sonication improved the solubility, swelling power and water retention of sorghum starch

◆Sonication is a potential processing technique to improve digestibility and properties of sorghum starch to further the utilization of sorghum as food and food ingredient

## What's Next?

◆Explore more sorghum varieties to test the result consistency or possibly to find a variety that have an even better outcome than other sonicated sorghum varieties.

◆Development of product using sonicated sorghum starch, such as **bread**, **noodle** and **sauce thickener**. And to compare with other starch product to see any distinguished characteristics.

◆Determination of any health promoting effects of sonicated sorghum starch.

## Reference

1. Awika, J. M., & Rooney, L. W. (2004). Sorghum phytochemicals and their potential impact on human health. Phytochemistry, 65(9), 1199–1221.
2. Zhao, R., Bean, S. R., & Wang, D. (2008). Sorghum protein extraction by sonication and its relationship to ethanol fermentation. Cereal Chemistry, 85, 837–842.
3. Chemat, F., Rombaut, N., Meullemiestre, A., Turk, M., Perino,S., Fabiano-Tixier, A. S., & Abert-Vian, M. (2017). Review of green food processing techniques. Preservation, transformation, and extraction. Innovative Food Science and Emerging Technologies, 41, 357–377.

## Acknowledgement

**Dr. Angela McClure for providing sorghum samples.**