## Characterization of starches extracted from sorghum varieties cultivated in colder regions: implications for food applications

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## ABSTRACT

Sorghum is a nutrient-dense, resilient, and multifunctional crop suitable for circular economy and advancing food security goals. The food applications of sorghum in colder regions such as Canada are limited, and this is primarily due to cultivation challenges in these climates. Recent breeding strategies demonstrated promising results in cultivating sorghum varieties to adapt to these cold climates to promote their utilization. This study focused on the extraction and analysis of starch from seven sorghum varieties of which five are from the Netherlands (white: HD7, brown: HD19, and three black varieties: HD100, HD101, HD102) specifically bred to adapt to cool climates above 51° Northern Latitude 3° Eastern Latitude and two varieties from Canada (white:CGSH-9 and red:CGSH-28) bred to thrive in areas with 2700 corn heat unit. Wet milling of sorghum was carried out to obtain starch for physicochemical and functional analysis. The extracted starches were analyzed to assess their suitability for various food applications. Pasting properties were evaluated using Rapid Visco Analysis (RVA), while thermal properties were determined through Differential Scanning Calorimetry (DSC). Particle size and morphology were analyzed using Scanning Electron Microscopy (SEM), while X-ray diffraction (XRD) patterns and relative crystallinity were studied to understand the crystalline structures. The Dutch varieties produced starch with a percentage yield between 18% (HD100) to 41% (HD7) whilst the Canadian varieties had a starch yield of 38%. SEM analysis showed that all the sorghum varieties were polymorphic with particle sizes between 1µm and 20µm. Colorimetric analysis showed that CGSH-9 was the lightest with L\*a\*b\* values of 92.49±0.04, -0.15±0.02, and 5.11±0.00 while the brightest HD102 had values of 82.63±0.01, 4.23±0.01, and 5.09±0.02. All samples depicted type-A starch with XRD peaks at angle 20 values of 15° and 23° and undifferentiated double peaks between 17° and 18°. The relative crystallinity of the starches from the XRD pattern ranged between 24% to 31% corresponding to HD7 and CGSH- 28 respectively. From the RVA analysis, the Dutch sorghum varieties had higher pasting properties as compared to the Canadian varieties with HD7 having the highest peak viscosity (3842±49cP) and CGSH-9 having the least peak viscosity (2672±13cP). The DSC analysis showed a gelation temperature range between 61.86±1.66°C to 77.44±1.86°C with an average temperature range of 15.59°C.

These findings validate the potential of these newly bred sorghum accessions, specifically tailored for cold climates, as viable substitutes for gluten containing starches in both industrial applications and consumer consumption.