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Colorimeter determination of starch damaged in flour in Juba, South Sudan

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ABSTRACT

The colorimetric determination of damaged starch in flour is a widely used method for assessing the quality and functionality of flour. Damaged starch refers to starch molecules that have undergone physical or chemical changes, resulting in a loss of their original structure and properties. The objective of the study was to assess the quality of flour by determining the extent of starch damaged for both processed and milled flour. The study was conducted in Chemistry Laboratory at University of Juba, Juba, South Sudan. Samples were collected from Munuki market. analyzed using Farrand Colorimeter Determination method. The results showed that the processed flour had 42% damaged starch and milled flour had 26.5% damaged starch which indicated that processed flour had higher damaged starch while the milled flour had lower damaged starch. The colorimetric determination of starch damaged in flour using a colorimeter in this study was a reliable and efficient method for assessing the quality of flour. By measuring the absorbance of a starch-iodine complex at a specific wavelength, this technique allowed for the quantification of starch damage in the flour samples.

Key words: Starch, Damaged, Flour, Juba, South Sudan

INTRODUCTION

The colorimetric determination of damaged starch in flour is a widely used method for assessing the quality and functionality of flour (Farrand, 2015).

Damaged starch refers to starch molecules that have undergone physical or chemical changes, resulting in a loss of their original structure and properties, these changes can occur during milling, storage, or processing of the grain, and they can significantly affect the performance of flour in various food applications (Apriyanto *et al*., 2016).

The determination of damaged starch is crucial for both producers and users of flour; Flour producers need to monitor the level of damaged starch in their products to ensure consistent quality and meet regulatory standards (Shewry and Tatham, n.d.).

On the other hand, users of flour, such as bakers and food manufacturers, rely on accurate measurements of damaged starch to optimize their formulations and achieve desired product characteristics and colorimetric determination methods offer a practical and reliable approach for quantifying damaged starch in flour, these methods involve the reaction of specific reagents with damaged starch molecules, resulting in the formation of colored compounds (Pérez *et al*., 2009). Intensity of the color developed is directly proportional to the amount of damaged starch present in the sample, allowing for quantitative analysis (BeMiller and Whistler, 2009).

The determination of damaged starch in flour is a critical aspect of quality control in the milling and baking industries. Starch, a polysaccharide composed of glucose units, exists in two forms: amylose and amylopectin. The integrity of starch granules is crucial for the functional properties of flour, particularly in baking applications where starch plays a significant role in water absorption, dough viscosity, and overall texture (Haug *et al*., 2018).

Damaged starch refers to starch granules that have been disrupted during milling processes. This damage can lead to increased water absorption and altered gelatinization properties, which are essential for dough performance (Baker and Hamer, 2019). The extent of starch damage can significantly influence the quality of baked products; therefore, accurate measurement methods are necessary for millers and bakers to ensure product consistency.

Colorimetric methods for determining damaged starch involve the use of specific reagents that react with the free hydroxyl groups present on the damaged starch molecules. These reactions produce color changes that can be quantitatively measured using spectrophotometry (Kumar *et al*., 2020). The intensity of the color produced correlates with the concentration of damaged starch present in the sample. This method is favored due to its simplicity, speed, and cost-effectiveness compared to more complex analytical techniques such as chromatography or microscopy.

In recent years, advancements in colorimetric assays have improved sensitivity and specificity for detecting damaged starch. For instance, modifications to traditional iodine-staining techniques have enhanced their applicability across various flour types (Zhang *et al*., 2021). Additionally, researchers are exploring alternative reagents that may provide better differentiation between damaged and undamaged starches (Li *et al*., 2022). The challenge faced in accurately measuring the level of damaged starch using the colorimetric method (Smith and Jones, 2020).

The objective of study was to detect the percentage of damaged starch present in flour during process of processing and milling and to assess the quality of flour by determining the extent of starch damaged for both processed and milled flour.

MATERIALS AND METHODS

Study area

The study was conducted in chemistry laboratory at university of Juba, in Juba County, Central Equatoria State, South Sudan. Juba City is situated at latitude 4°51′5.94″N and longitude 31°34′56.89″E, at an elevation of 518 m above sea level, covering approximately 1,699 km².

Research design

The method of study was conducted using primary data prepared in chemistry laboratory at University of Juba.

Sample collection, preparation and experimental procedures

The sample were collected from Munuki market. The marked was purposively selected due to the availability of research samples of the studied materials. Flour samples were collected from Munuki Market, from different types of grains (Cassava, Maize, Millet and Wheat).

A weight of 0.5g of flour was measured and placed amount of weighted flour into a test tube, then add 10ml of distilled water in test tube and mixed well to form a paste, adding a 2-3 drops of iodine solution into the paste, then mixed well a solution for 10-15 minutes until blue color appeared, and absorbance value measures were taken using colorimeter, then a few drops of sodium thiosulfate were added into the mixture using titration method until the color changed (blue color disappear) from blue to colorless.

Data analysis

The data were analyzed using Microsoft excel.

RESULTS

Detection of the damaged starch in milled flour

The findings in Table 1 showed that the damage starch content in milled flour have less damage starch present in the samples that have been tested, where by a cassava is the best among others like mazie, wheat and millet respectively. Hence, the percentages of damage starch present in cassava are 22% followed by maize (23%), wheat with 25% and millet with 35%.

Table 1. Detection of damage starch in milled flour

Sl	Sample	R1	R2	R3	Mean
1	Maize	0.25	0.21	0.24	0.23
2	Millet	0.54	0.25	0.27	0.35
3	Cassava	0.24	0.24	0.19	0.22
4	Wheat	0.33	0.05	0.37	0.25
Total avg.					0.25

Where; R1, R2, and R3 = Number of tests. Reference of flour damaged starch content ranges from 0.3%-55.8% f with absorbance ranged from 0.074 -1.07nm (Farrand, 2015).

Detection of the damaged starch in processed flour

The findings in Table 2 showed that the processed flour has much damage starch content of (0.421667) which is 42 %. the processed flour also indicated that cassava has less damaged starch 37% followed by Maize (41%) and 45% for both wheat and millet.

Table 2. Detection of damage starch in processed flour

Sl	Samples	R1	R2	R3	Mean
1	Maize	0.47	0.37	0.39	0.41
2	Millet	0.41	0.54	0.4	0.45
3	Cassava	0.62	0.18	0.33	0.37
4	Wheat	0.49	0.43	0.43	0.45
Total avg.e					0.42

Where; R1, R2, and R3 = Number of tests. Reference of flour damaged starch content ranges from 0.3%-55.8% f with absorbance ranged from 0.074 -1.07nm (Farrand, 2015).

Comparison between the detected damage starch in procced flour and milled flour

The findings in Table 3 indicated that the processed flour had a much damage starch content of 42 % where the milled flour had less damage starch content of 26.5%.

Table 3. Comparison between the detected damaged starch in processed and milled flour

Sl	Samples	Processed flour				Milled flour			
		R1	R2	R3	Mean	R1	R2	R3	Mean
1	Maize	0.47	0.37	0.39	0.41	0.25	0.21	0.24	0.23
2	Millet	0.41	0.54	0.4	0.45	0.54	0.25	0.27	0.35
3	Cassava	0.62	0.18	0.33	0.37	0.24	0.24	0.19	0.22
4	Wheat	0.49	0.43	0.43	0.45	0.33	0.05	0.37	0.25
Total avg.					0.42				0.26

DISCUSSION

In This study the result of colorimetric determination of starch damaged in flour, showed out that there are different percentages of damaged starch contents in the samples studied. The study results indicated that the milled flour has better quality of flour than processed flour and all percentages have fallen within the standard ranges. The findings also showed that the processed flour has 42.2% and milled flour has 26.5% which showed that the processed flour has higher damaged starch while the milled flour has lower damaged starch. This study is in line with/ supported by (Farrand, 2015) experimental work. Their results illustrated that there were severe damages in processed starch contents ranged from 0.3%-55.8%. Hence, the milled flour had better quality of flour than processed flour.

CONCLUSION

1. The colorimetric determination of starch damaged in flour using a colorimeter is a reliable and efficient method for assessing the quality of flour. By measuring the absorbance of a starch-iodine complex at a specific wavelength, this technique allows for the quantification of starch damage in flour samples.
2. The colorimeter provides accurate and reproducible results, making it a valuable tool for quality control in the food industry.
3. Additionally, this method is relatively simple to perform and does not require extensive training, making it accessible to a wide range of users.

RECOMMENDATIONS

1. It is recommended that food manufacturers, quality control laboratories and South Sudan National Bureau of Standard should consider implementing colorimetric determination using a colorimeter for assessing starch damage in flour.
2. The milled flour is best in quality than processed flour. This method can help ensure the consistency and quality of flour products, leading to improved consumer satisfaction and overall product success.
3. The food manufacturers should consider the use of spectrophotometer.

LIMITATIONS

There were several limitations to consider:

Interference from other substances: The presence of other substances in the flour sample can interfere with the colorimetric determination of damaged starch. Substances such as proteins, lipids, and sugars may contribute to the color development, leading to inaccurate results.

Variability in sample composition:

The composition of flour samples can vary depending on factors such as wheat variety, processing conditions, and storage conditions. This variability can affect the accuracy and reproducibility of colorimetric measurements.

Sensitivity of the method:

Colorimetric methods may not be sensitive enough to detect low levels of damaged starch in flour. This limitation can be particularly problematic when trying to assess the extent of starch damage in samples with low levels of damage.

Sample preparation:

Proper sample preparation is crucial for accurate colorimetric measurements. Inadequate sample homogenization or extraction procedures can lead to uneven distribution of components in the sample, affecting the reliability of the results.

Instrument calibration:

The calibration of the colorimeter is essential for accurate measurements. Improper calibration or maintenance of the instrument can introduce errors into the results, compromising the reliability of the analysis.

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