

Teff Milling and Flour Analysis

Food Development Centre Project #4869

Final Report

Submitted to:

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1.0 INTRODUCTION

Parkland Crop Diversification Foundation (PCDF), is a non-profit organization that partners with research and industry to conduct applied research which evaluates, demonstrates and facilitates the use of new crops, technologies and value-added opportunities. PCDF is currently assessing the potential for teff as a new Manitoba crop. PCDF wishes to establish nutrient composition and quality attributes for flour processed from the two seed samples.

PCDF has requested that the Food Development Centre (FDC) mill two samples of teff seed (Hayed and Not Hayed) and send samples for analysis of the nutritional and quality attributes. The two teff crops were harvested in 2022: 1) at full maturity (Not Hayed) and 2) after the crop was cut for forage, and then allowed to regrow to maturity (Hayed).

Teff is a type of ancient grain that is a species of lovegrass (*Eragrostis tef*) or Williams' lovegrass that is native to the Horn of Africa. It is cultivated largely in Ethiopia and Eritrea for its edible seeds which are roughly the size of poppy seeds and come in a variety of colors ranging from white to red to dark brown. These seeds are typically ground into a whole-grain flour (including bran and germ) which results in a gluten free flour with very high fibre and nutrient content. Teff is comparable to wheat in food value, and is potentially even more nutritious. The crude fibre content of teff is higher than most other gluten and non-gluten containing cereals. This flour has an excellent balance of amino acids, including all 8 essential amino acids for humans. Teff flour is used to make a variety of baked goods including the traditional bread known as injera, a fermented pancake-like bread. (2)

2.0 OBJECTIVES

The project objectives included milling teff grain into flour and testing the flour for nutritional and quality attributes. Milled product was then sent to Central Testing Laboratories for the following tests: Falling Number, Starch Damage, Starch (Megazyme), Amylase, Available Carbohydrate for Humans, Estimated Calories for Humans, % Moisture, % Dry Matter, % Crude Protein, Total Dietary Fibre, % Fat, and % Ash.

3.0 MILLING PARAMETERS

Teff seed; 19.67 kg (not hayed) and 7.90 kg (hayed) was received at FDC on February 14, 2023. Product was stored in dry storage at ambient temperature until scheduled milling date. Product was milled on February 23, 2023 using a Fitzmill Comminutor model #DAS 06 using a 0.020-inch screen. Product was packaged in 2.5 kg portions in silver wicketed Mylar bags. The 19.67 kg of seeds from the Hayed crop produced 18.55 kg of flour and the 7.90 kg seeds from the Not Hayed crop produced 7.58 kg of flour.

One kilogram of each milled Teff sample was submitted to Central Testing Laboratory for chemical and quality analysis and 200 g of each sample was tested for particle size distribution at FDC.

4.0 TESTING METHODOLOGY

Falling number

Falling number is a measure of the enzyme activity in flour. It is related to the amount and activity of α -amylase, which is present in the grain after harvesting. It is a lab test in which a slurry is made of flour and water, placed in a test tube and measures how many seconds it takes for a plunger to fall through the slurry to the bottom of the test tube. Higher falling number means it takes longer for the plunger to fall through the slurry; this means there is a low enzymatic activity in the grain and it has not begun to germinate. If a falling number is low it means the grain has begun to germinate, enzymatic activity is high and the plunger falls through the slurry quickly (4).

Optimal falling number for baking bread with wheat flour is generally 200-300 seconds. Wheat flours with a falling number below 120 seconds or higher than 300 seconds are not suitable for making a yeast leavened product (4). Conversely it has been found that Teff with falling numbers below 250 seconds result in products with an unattractive taste and/or structure. Storage of the teff seed after harvest results in a rise in falling number. If the seed is stored until the falling number is >300 seconds prior to milling, it results in a

flour which is free from these issues (2). It has also been found that Teff with a particle size $<150\ \mu\text{m}$ produces better quality product both in flavour and structure (3).

Starch Damage and Presence of Amylase

Starch damage and presence of amylase both relate to falling number. These tests are conducted to determine the best use of the flour, and if additives are required for the flour to perform as desired.

The proximate composition of foods includes moisture, ash, fat, crude protein and total dietary fibre contents among other components. These components are of interest in the food industry for product development, quality control (QC) or regulatory purposes.

When proximate composition of the teff milled at FDC are compared to that of whole wheat flour, the results are similar, teff having a slightly greater ash content than the standard for whole wheat flour.

Starch (Megazyme) analysis determines the total amount of starch in the flour. The results of analysis of the FDC milled teff product is similar to that of wheat. Literature indicates that teff has a higher starch content than most other cereal grains, this is one of the reasons it has great potential as a gluten free replacement for wheat and other cereals. (2)

Particle size distribution

The particle size distribution of the two trials was conducted at FDC. The test was performed by measuring 200 g of sample and running it through sieves of the following sizes $425\ \mu\text{m}$, $300\ \mu\text{m}$, $250\ \mu\text{m}$, $212\ \mu\text{m}$, $180\ \mu\text{m}$, $150\ \mu\text{m}$, and $125\ \mu\text{m}$. Results of the testing are found in Tables 3 and 4. The particle size of the teff milled at FDC is within the range of the standard for whole wheat flour, however it has been discovered that Teff which has a particle size $<150\ \mu\text{m}$ produces better quality product both in flavour and structure. (3) It is suggested that the pin mill is the best process for milling teff seeds and to have 50% or more of the flour to have a particle size of $<150\ \mu\text{m}$ (3).

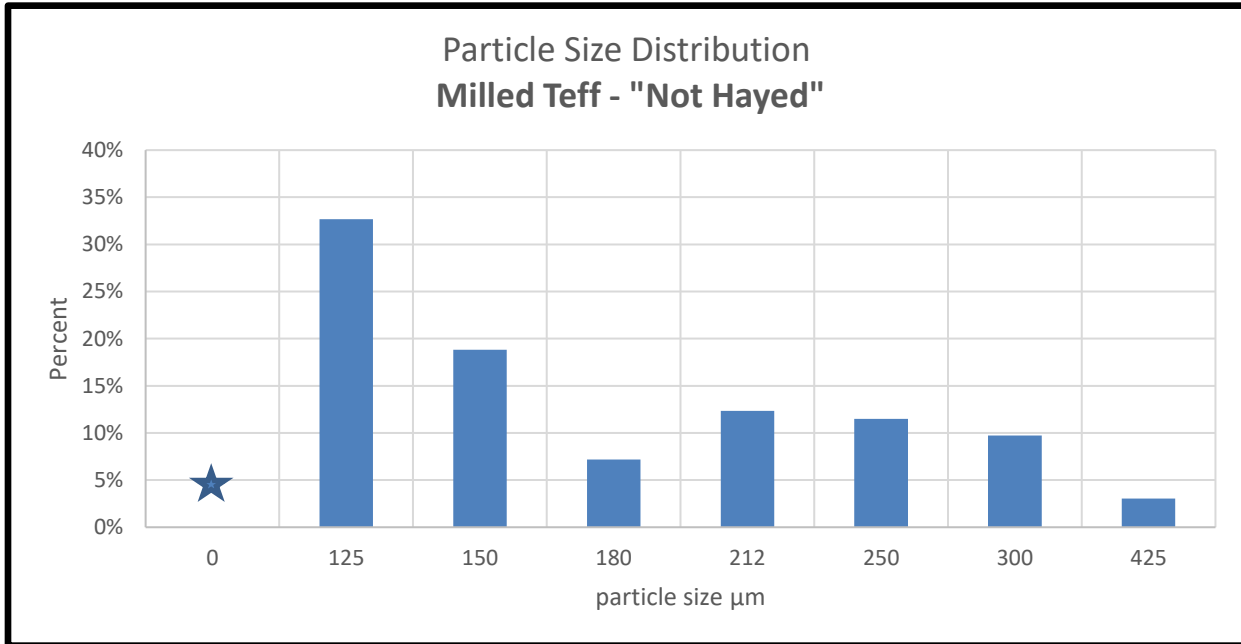
Table 1. Comparison of teff and whole wheat flour

Analysis	As Received (Not Hayed)	As Received (Hayed)	Whole Wheat Flour (King Arthur Flour Company)	Standard of Identity Whole Wheat Flour Food and Drug Regulations (C.R.C., c. 870)
Moisture	9.18%	8.76%	14.00%	Not more than 15.00%
Dry Matter	90.82%	91.24%	86.00%	NA
Crude Protein (as is)	12.73%	13.09%	14.00%	NA
Total Dietary Fibre	8.34%	9.63%	10.70%	NA
Fat (as is)	3.29%	2.77%	2.5%	NA
Ash (as is)	2.42%	2.34%	>1.5%	≥1.25% and ≤ 2.25%
Falling Number	224 seconds	330 seconds	350 seconds	NA
Amylase	Positive	Positive	NA	NA
Starch (Megazyme) (as is)	60.41%	62.05 %	68% (carbohydrate)	NA
Available Carbohydrate for Humans (g/100g)	64.04	62.05	NA	NA
Estimated Calories for Humans (g/100g)	337	331	NA	NA
Starch Damage	Appendix B	Appendix C	NA	NA
Particle size	5% <125 µm 71% <212 µm 24% >212 µm	4% <125 µm 59% <212 µm 43% >212 µm	<212µm	>90% 2380µm and >50% 840µm

5.0 RESULTS

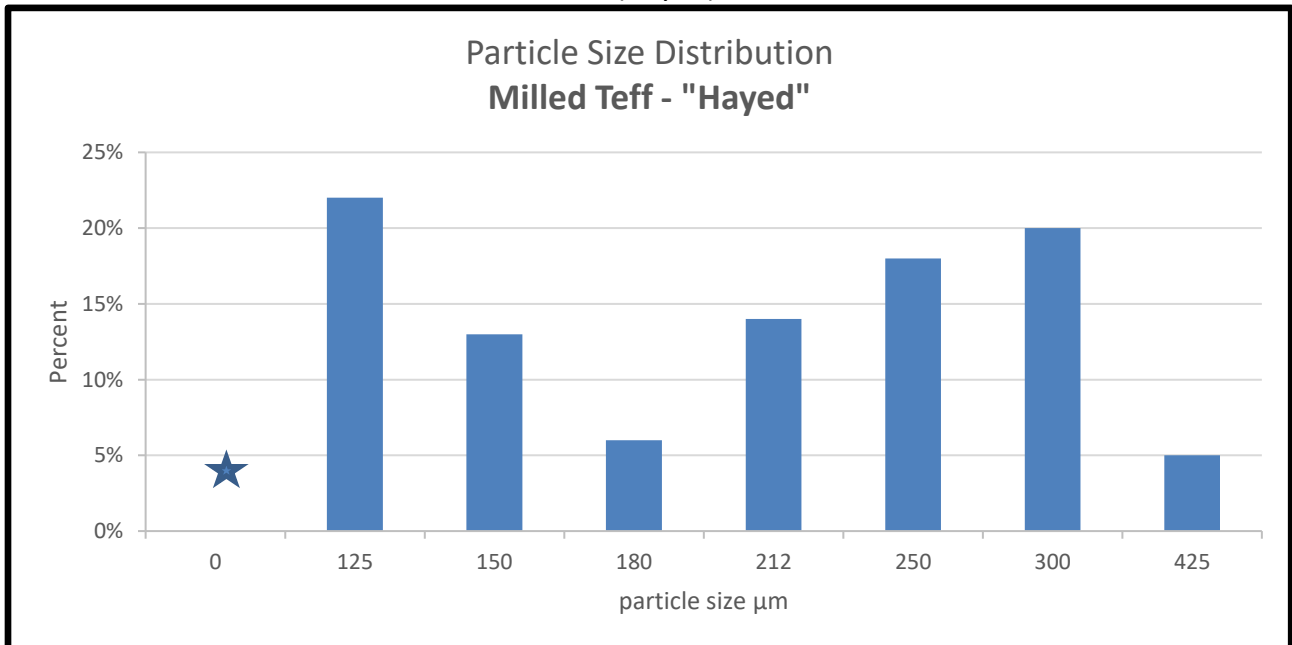
When comparing the falling number values between the two teff trials, the sample from the “Not Hayed” trial had a falling number lower than 250 seconds (Table 1) indicating that the flour would be similar to traditional teff flour which was milled shortly after harvest. The second trial sample of the ‘Hayed” teff flour had a falling number greater than 300 seconds (Table 1) indicating it will have better flavour and structure in baked goods (2). For complete laboratory report see Appendices A, B, and C.

Table 2. Particle size distribution of milled teff (Not Hayed)



★ NOTE: Particle size: 5% <125 μm, 71% <212 μm, 24% >212 μm.

Table 3. Particle size distribution of milled teff (Hayed)



★ NOTE: Particle size: 4% <125 μm, 59% <212 μm, 43% >212 μm.

6.0 REFERENCES

- (1) Gebremariam, M. M., Zarnkow, M., Becker, T. (2014). Teff (*Eragrostis Tef*) as a raw material for malting, brewing and manufacturing of gluten-free foods and beverages: a review. *Journal of Food Science and Technology*, vol. 51, (no. 11, 2014), pp. 2881–95,
- (2) Pulivarthi, M.K., Selladurai, M., Nkurikiye, E., Li, Y., Siliveru, K. (2022)., Significance of milling methods on brown teff flour, dough, and bread properties. *Journal of Texture Studies*, vol. 53, (no. 4, pp. 478–89,
- (3) Jans Roosejen, Hooghalen. Processing of Teff Flour. (United states of America Patent No. 2006/0286240 A1, 2006) , PCT Filed Jul.22, 2004
- (4) Understanding Falling Number In Cereal Crops - SARE projects.sare.org/wp-content/uploads/Falling-Number-Factsheet.pdf

APPENDIX A - CENTRAL TESTING LABORATORY LTD. TEST REPORT



CTL-TRT Rev 1.0 Revised: August 28, 2015

Phone: 204.237.9128
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 Email: info@ctl.mb.ca
 Website: www.ctl.mb.ca

Unit 9 - 851 Lagimodiere Blvd.
 Winnipeg, MB
 R2J 3K4

Laboratory #:
 639071

TEST REPORT

Submitted By:	
Food Development Centre Box 1240, 810 Phillips St. Portage La Prairie, MB R1N 3J9 Attn: Mallory Hulme	Phone #: 204-239-3732 Fax #: (204) 239-3180 Date Received: March 06, 2023 Date Printed: April 06, 2023

Client: **FOOD** Package #: 1F,FAT-EE,TDF,ASH,FALL#;Starch;Carbs
 Description: **FLOUR** Complete
Milled Teff, not hayed Sample #:
 Arrival Condition: **Sample Intact**

Analysis:	As Received	Dry Matter
Moisture (%) (test date 03/08/23)	9.18	
Dry Matter (%) (test date 03/08/23)	90.82	
Crude Protein (%) (test date 03/08/23)	12.73	14.02
Total Dietary Fibre* (%) (test date 04/05/23)	8.34	
Fat (%) (test date 03/09/23)	3.29	3.62
Ash (%) (test date 03/08/23)	2.42	2.66
Falling Number (test date 03/08/23)	224	
Amylase* (test date 04/05/23)	Positive	
Starch (Megazyme) (%) (test date 03/13/23)	60.41	66.52
Starch Damage* (test date 04/06/2023)	see related graph report 23-079-4059	
Available Carbohydrate for Humans (g/100g) (test date 04/06/2023)	64.04	
Estimated Calories For Humans (cal/100g) (test date 04/06/2023)	337	

Glenn Thompson
 Technical Laboratory Manager

Remarks:
 *Outsourced to: Merieux Nutrisciences (Markham), Unit 4 - 90 Gough Road, Markham, ON L3R 5V5; Starch Damage to: Midwest Laboratories C/O Merieux Nutrisciences (Markham)

*Results are based on the sample received and liability is limited to the cost of analysis.
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 Winnipeg, MB
 R2J 3K4

CTL-TRT Rev 1.0 Revised: August 28, 2015

Laboratory #:
 639072

TEST REPORT

Submitted By:	
Food Development Centre Box 1240, 810 Phillips St. Portage La Prairie, MB R1N 3J9 Attn: Mallory Hulme	Phone #: 204-239-3732 Fax #: (204) 239-3180 Date Received: March 06, 2023 Date Printed: April 06, 2023

Client: **Package #:** 1F,FAT-
Product: FOOD **Complete** EE,TDF,ASH,FALL#,Starch;Carbs
Description: FLOUR **Sample #:**
 Milled Teff, hayed
Arrival Condition: Sample Intact

Analysis:	As Received	Dry Matter
Moisture (%) (test date 03/08/23)	8.76	
Dry Matter (%) (test date 03/08/23)	91.24	
Crude Protein (%) (test date 03/08/23)	13.09	14.35
Total Dietary Fibre* (%) (test date 04/05/23)	9.63	
Fat (%) (test date 03/09/23)	2.77	3.03
Ash (%) (test date 03/08/23)	2.34	2.56
Falling Number (test date 03/08/23)	330	
Amylase* (test date 04/06/23)	Positive	
Starch (Megazyme) (%) (test date 03/13/23)	62.05	68.01
Starch Damage* (test date 04/06/23)	see related graph report 23-079-4080	
Available Carbohydrate for Humans (g/100g) (test date 04/06/2023)	63.41	
Estimated Calories For Humans (cal/100g) (test date 04/06/2023)	331	

Glenn Thompson
 Technical Laboratory Manager

Remarks:
 *Outsourced to: Merieux Nutrisciences (Markham), Unit 4 - 90 Gough Road, Markham, ON L3R 5V5; Starch Damage to: Midwest Laboratories C/O Merieux Nutrisciences (Markham)

*Results are based on the sample received and liability is limited to the cost of analysis.
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CTL-TRT Rev 1.0 Revised: August 28, 2015

Methods of Analysis

Food Development Centre
 Box 1240, 810 Phillips St.
 Portage La Prairie, MB R1N 3J9
 Att: Mallory Hulme

Phone #: 204-239-3732
 Fax #: (204) 239-3180

Date Reported: April 06, 2023

Test or Category	Method of Analysis
Falling Number.....	AACC 56-81B
Total Dietary Fibre.....	AOAC 991.43 (Mod.)
Available Carbohydrate for Humans.....	Calculation
Estimated Calories For Humans.....	Calculation
Ash.....	CTL-A2SOP
Fat.....	CTL-FSOP
Moisture.....	CTL-MASOP
Crude Protein.....	CTL-PDSOP
Starch (Megazyme).....	CTL-STRMEGSOP
Starch Damage.....	Perten RVA Manual
Amylase.....	Siliker Method

Method Reference for Laboratory #(s) 639071,639072

*Results are based on the sample received and liability is limited to the cost of analysis.
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APPENDIX B - CENTRAL TESTING LABORATORY LTD. GRAPH REPORT 23-079-4059

TCW3 Report 23-079-4059
 3/20/2023 10:14:33AM User RVA Station

Laboratory # 639071

Security ID = 130606150946099

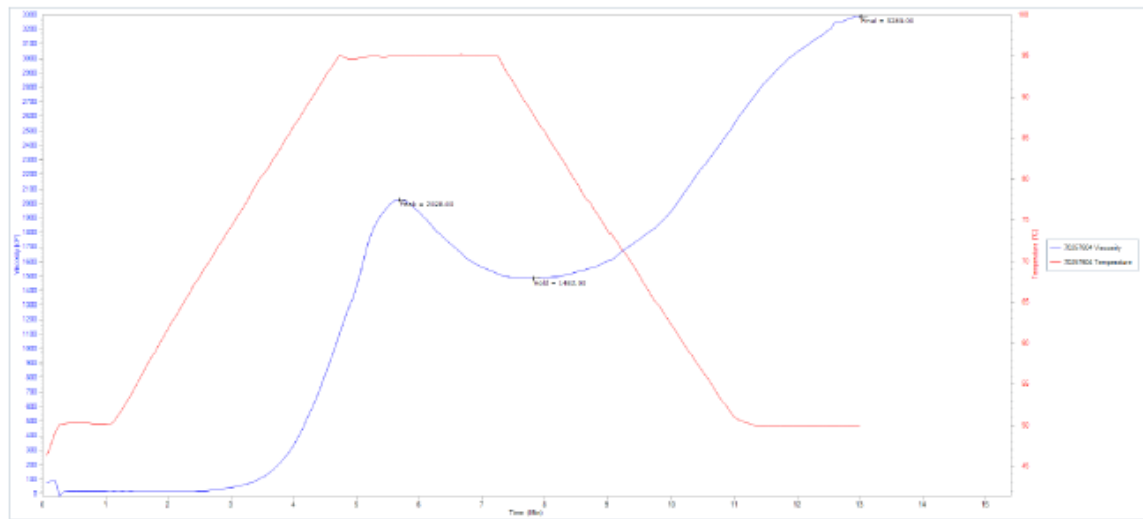
Test Details Samples

01 \\nwlad.midwestlabs.com\data\Users\rvastation\Documents\TCW3 Data\70257604			
Date 2023/03/20	Time 09:52:26	Tester RVA Station	Instrument 2143181
Sample Weight 3.86 (g)	Water Weight 24.64 (g)	Sample Moisture 9.38 (%)	Moisture Basis 0.00 (%)

Test Results

Test	Peak 1	Trough 1	Breakdown	Final Visc	Setback	Peak Time
01 70257604	2026.00	1482.00	546.00	3289.00	1807.00	5.67

Test	Pasting Temp
01 70257604	80.15



APPENDIX C - CENTRAL TESTING LABORATORY LTD. GRAPH REPORT 23-079-4060

TCW3 Report 23-079-4060
 3/20/2023 10:34:49AM User RVA Station

Laboratory # 639072

Security ID = 130606150946099

Test Details Samples

01	\\mwlad.midwestlabs.com\data\Users\rvastation\Documents\TCW3 Data\70257605		Instrument 2143181
	Date 2023/03/20	Time 10:15:25	Tester RVA Station
	Sample Weight 3.83 (g)	Water Weight 24.67 (g)	Sample Moisture 8.61 (%)
			Moisture Basis 0.00 (%)

Test Results

Test	Peak 1	Trough 1	Breakdown	Final Visc	Setback	Peak Time
01 70257605	1774.00	1329.00	445.00	2771.00	1442.00	5.60

Test	Pasting Temp
01 70257605	80.75

