

***2023 Pulse Quality  
Evaluation***

---

# Faba Bean



## **Pulse Quality Program—*Mission***

The Pulse Quality Program launched in spring 2022 with a partnership between Saskatchewan Pulse Growers and the Saskatchewan Food Industry Development Centre with the mission to add in best management practices for pulses grown in Western Canada and to help the development of pulse-based ingredients/products in the food industry.

The program aims to develop a comprehensive database of composition, functionality, and nutrition for pulses that provides information to growers, agronomists, breeders, buyers, and end users to make more informed choices. This program implements a genotype by environment (G x E) evaluation of quality parameters of peas, faba beans, lentils, chickpeas, and dry beans.

Phase 1 of the program analyzes up to 3000 samples annually from regional variety trials. The main focus of parameters includes seed quality (i.e., thousand kernel weight, amount of damage, seed size, and seed hardness), nutritional composition (i.e., ash, moisture, and protein content), milling, and colour. The generated data are compared across pulse varieties, locations, and years. Additional parameters will be considered in future years in Phase 2 and Phase 3.

## 2023 Faba Bean Quality

A total of **288** faba bean samples harvested in **2023** were acquired from **eight locations**, including Glaslyn, Goodale, Melfort, Prince Albert, Redvers, Roblin (MB), St Brieux, and Swan River (MB). Both **tannin-type** (six varieties) and **zero-tannin type** (six varieties) were harvested in each location, and three replicates of each variety were cultivated in each location. **Table A** and **Figure A** provide the samples' information and locations in detail.

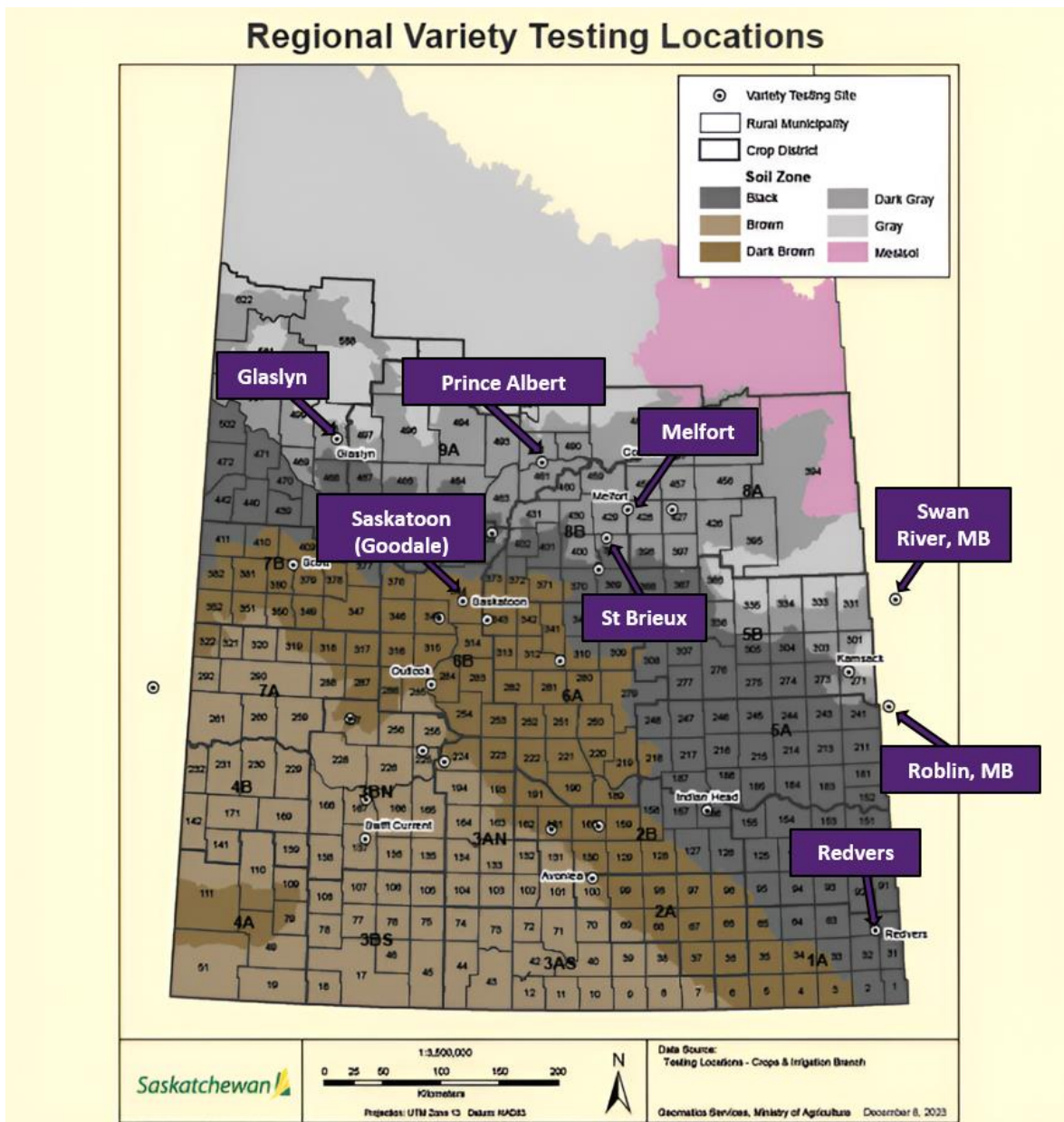
**Figure B** provides the cumulative rainfall from April 1 to October 16, 2023. Overall, there was more rainfall in the southeast, east-central, northeast and northwest regions than in the southwest and west-central regions. According to the 2023 Crop Reports by the Ministry of Agriculture, seeding started in early May due to cool weather and excess moisture in April, and seeding was wrapped up in the beginning of June. During the growing season, warm temperatures have accelerated crop development in the majority of the province, especially the southwest and west-central regions, and harvest began in these regions at the end of July. Harvest was completed by the end of September.



**Table A.** Description of 2023 faba bean samples tested for the Pulse Quality Program. Varieties also present in 2022 are shown in black, and new varieties that entered in 2023 are shown in red.

| Crop      | Type        | Variety   | Location   | Number of samples |
|-----------|-------------|-----------|--|-------------------|
| Faba bean | Tannin      | Allison   | Glaslyn<br>Goodale<br>Melfort<br>Prince Albert       | 288               |
|           |             | Fabelle   |  |                   |
|           |             | Victus    |  |                   |
|           | Zero-Tannin | CDC 1089  | Redvers<br>Roblin, MB<br>St Brieux<br>Swan River, MB |                   |
|           |             | CDC 1142  |  |                   |
|           |             | DL Nevado |  |                   |
|           |             | Navi      |  |                   |
|           |             | 1239-1    |  |                   |
|           |             | CDC 1310  |  |                   |
|           |             |           |  |                   |





The cropland of Saskatchewan has been divided into four areas based roughly on agro-climatic conditions. Crop yields can vary from area to area. In choosing a variety, producers will want to consider the yield data in combination with marketing and agronomic factors.

**Area 1:** Drought is a definite hazard and high winds are common. Sawfly outbreaks often occur in this area. Cereal rust may be a problem in the southeastern section.

**Area 2:** Drought and sawfly may be problems in the western and central sections of the area. Cereal rust may be a problem in the southern section.

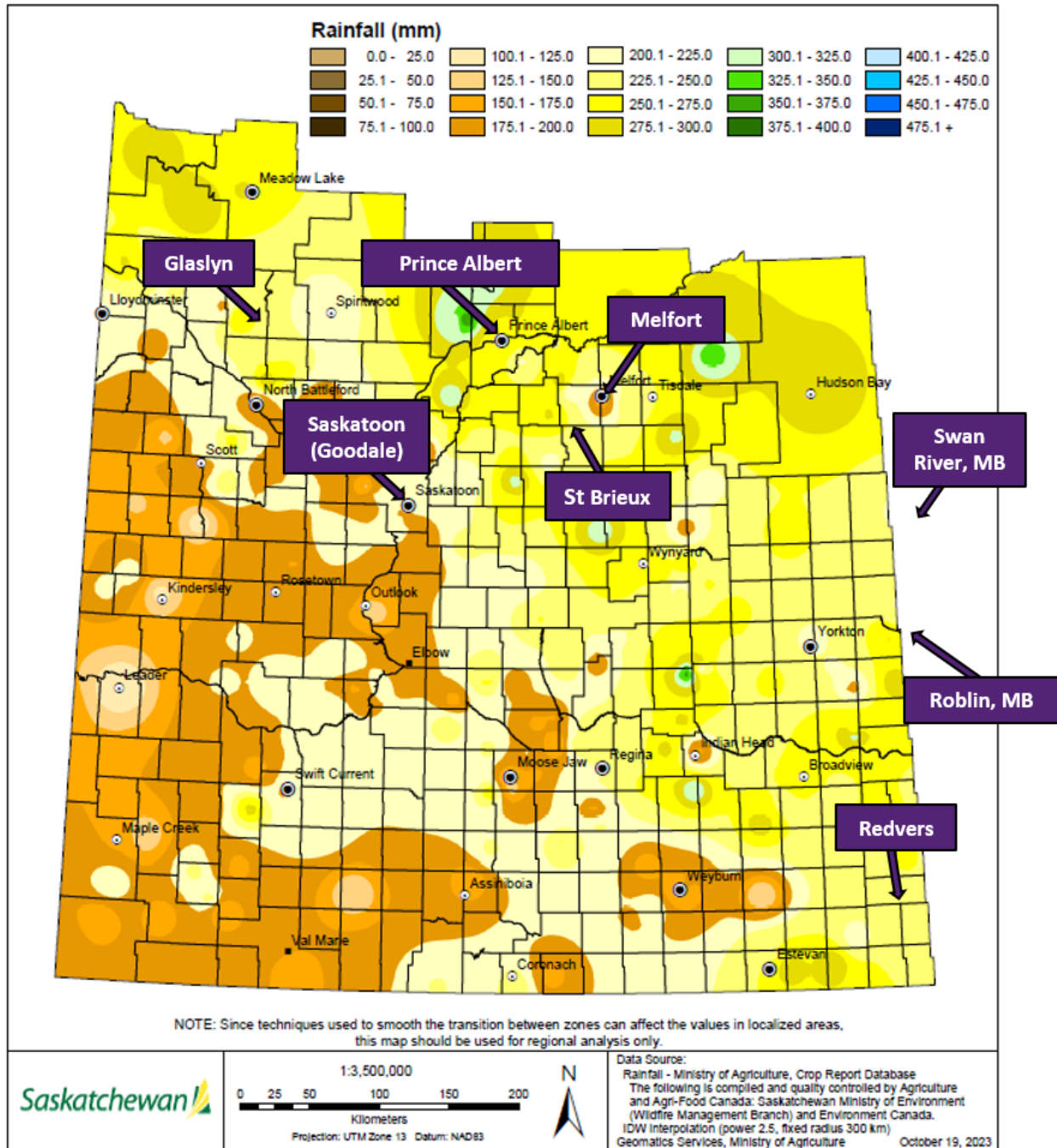
**Area 3:** Sawfly can also be a problem. Drought is not as likely to be a problem in this area, particularly in the east. Cereal rust may occur in the eastern portion. The frost-free period can be fairly short in the northern section.

**Area 4:** Rainfall is usually adequate for crop production. However, early fall frosts and wet harvest conditions are frequent problems.

**Note About Dividing Lines:**  
 The dividing lines do not represent distinct changes over a short distance. The change from one area to another is gradual.

**Figure A.** Locations for faba bean quality testing in 2023 and the corresponding soil zones. Figure was modified from material provided by the Saskatchewan Ministry of Agriculture.

## Cumulative Rainfall from April 1 to October 16, 2023



**Figure B.** Locations for faba bean quality testing and cumulative rainfall from April 1 to October 16, 2023. Figure was modified from material provided by the Saskatchewan Ministry of Agriculture.

This report includes eleven subsections for the results of the following quality parameters:

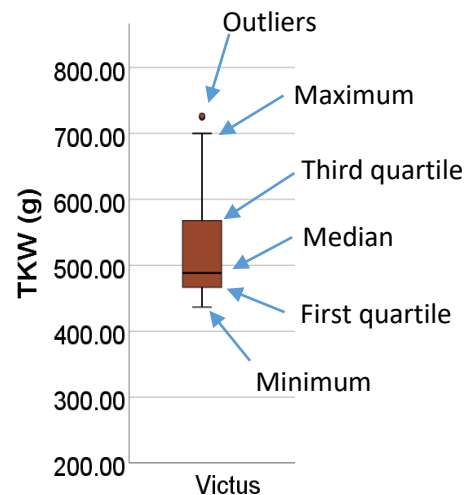
1. Yield
2. Thousand kernel weight (TKW)
3. Seed size: length, width, thickness
4. Split amount
5. Hull perforation due to insects or disease
6. Other damage
7. Hardness of whole seed
8. Ash content
9. Protein content
10. Protein productivity
11. Colour ( $L^*$ ,  $a^*$ , and  $b^*$ )

The **method** used to evaluate each quality parameter is provided at the beginning of each subsection.

For the **results**, a **Box and Whisker** plot is first provided to show the full dataset of each variety, where the minimum, median, maximum, first quartile (the median of the lower half of the dataset), and third quartile (the median of the upper half of the dataset).

In addition, a **Bar** graph is included to provide the mean values by variety to show the variety performance and by location to show how the locations differed.

Furthermore, the effects of variety, location, and variety x location on the characteristic are given in a **table**.



For **statistics**, a one-way analysis of variance (ANOVA) along with a post-hoc Tukey test (SPSS, Chicago, IL, USA) was performed to identify the differences in the quality parameters, including yield, TKW, seed size, seed hardness, split + cracked seed coat, other damage, protein, protein productivity, ash, Hausner ratio, colour, and particle size, by variety and by location.

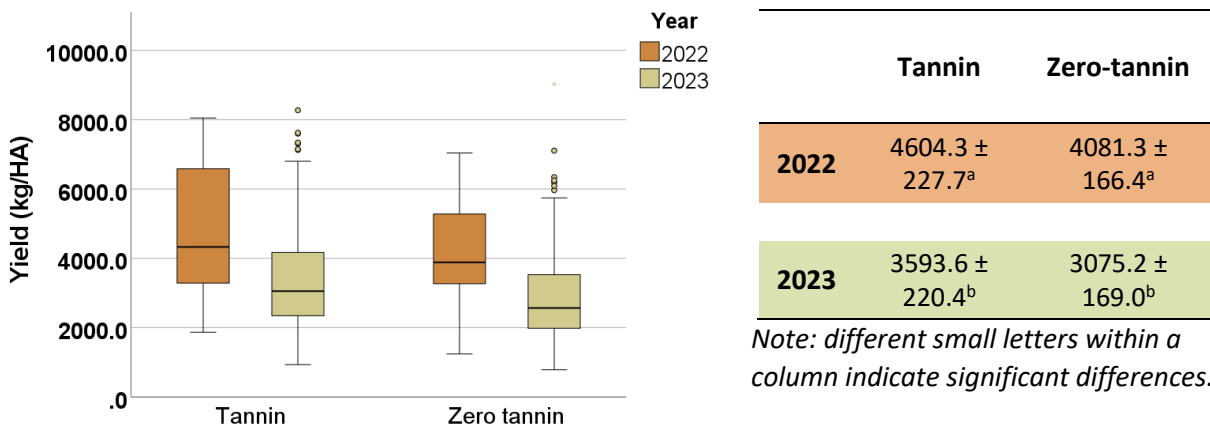
A two-way analysis of variance (ANOVA) was conducted to determine the effects of variety, location, and their interaction on each parameter.

## 2023 Faba Bean Quality

### 1. Yield

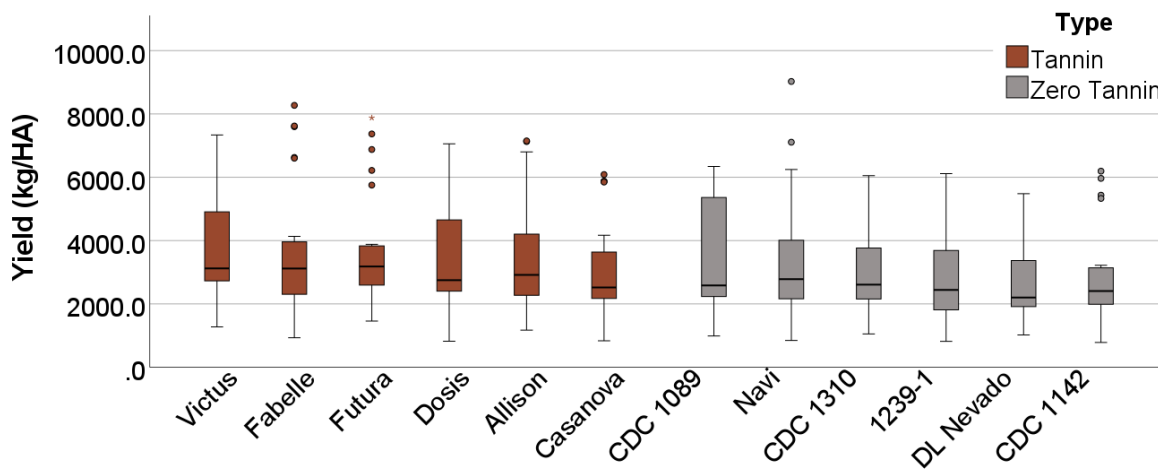
**Method:** Yield refers to how much crops are produced and how efficiently land is used to produce food or agricultural commodities. The yield of each variety from each location is provided as kilogram per hectare (kg/HA).

**Results: Figure 1.1. & Table 1.1.** Yield of faba beans in 2022 and 2023. Data in the table represent mean  $\pm$  one standard error. The data in the figure and table include only the varieties tested in both years; see the varieties shown in black in Table A (p. 2).



- The yield of 2023 was significantly lower than in 2022 for both types ( $p < 0.05$ ).
- Tannin type tended to have a greater yield than the zero-tannin type.

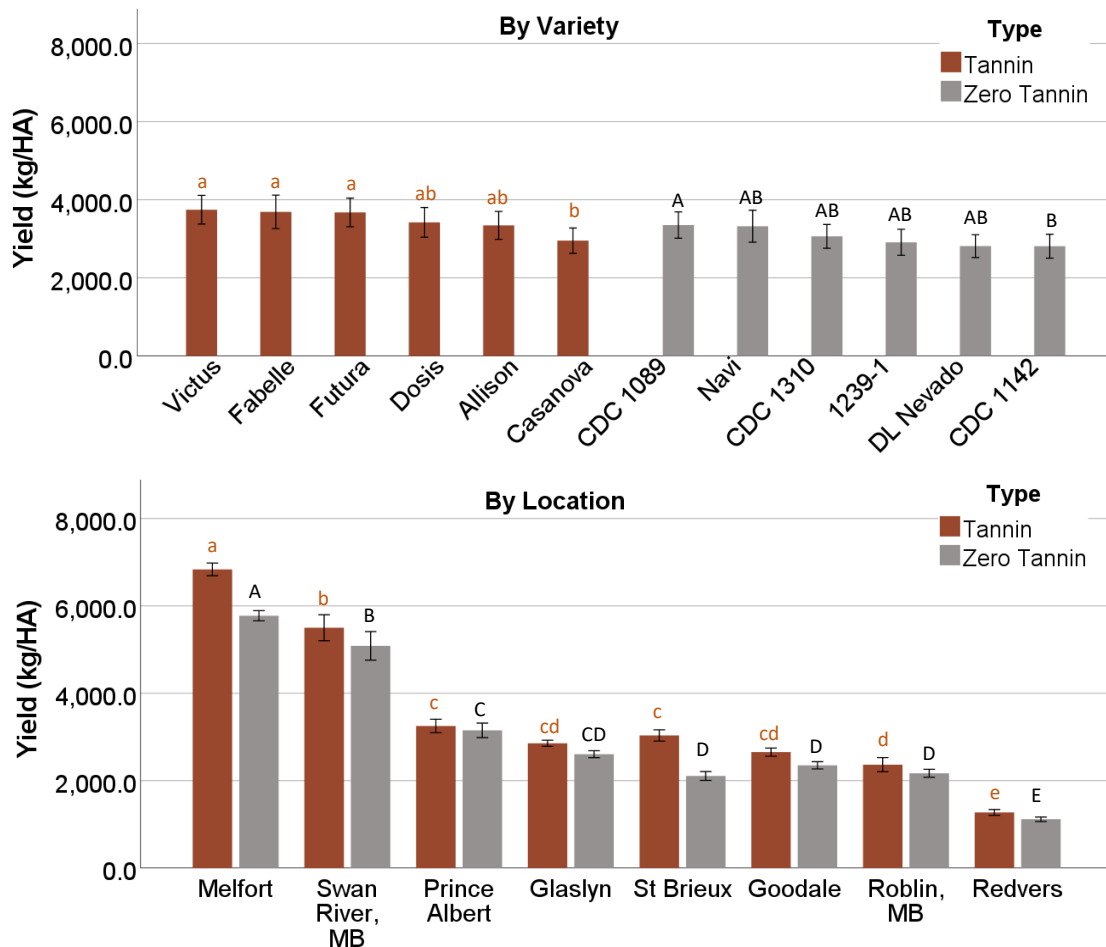
**Figure 1.2.** Box and Whisker plot of 2023 faba beans for yield. Results by type were reported from highest to lowest.



- High variability in yield was observed across all varieties.



**Figure 1.3.** Mean yield of 2023 faba beans by variety (top) and by location (bottom). Each bar represents mean  $\pm$  one standard error.



Note: Small letters indicated significant differences ( $p < 0.05$ ) between tannin varieties. Capital letters indicated significant differences ( $p < 0.05$ ) between zero-tannin varieties.

- **By Variety:** Variety effect was minor.
  - **Tannin:** A difference of 792 kg/HA was found from highest to lowest.
  - **Zero Tannin:** A difference of 542 kg/HA was found from highest to lowest.
- **By Location:** Yield varied significantly across locations, with Melfort showing the highest yield (tannin: 6837 kg/HA; zero-tannin: 5775 kg/HA). In contrast, Redvers had the lowest yield, with both faba bean types yielding below 1300 kg/HA.

**Table 1.2.** Effects of variety and location in 2023.

|                           | Tannin | Zero-Tannin |
|---------------------------|--------|-------------|
| <b>Variety</b>            | **     | *           |
| <b>Location</b>           | ***    | ***         |
| <b>Variety x Location</b> | NS     | NS          |

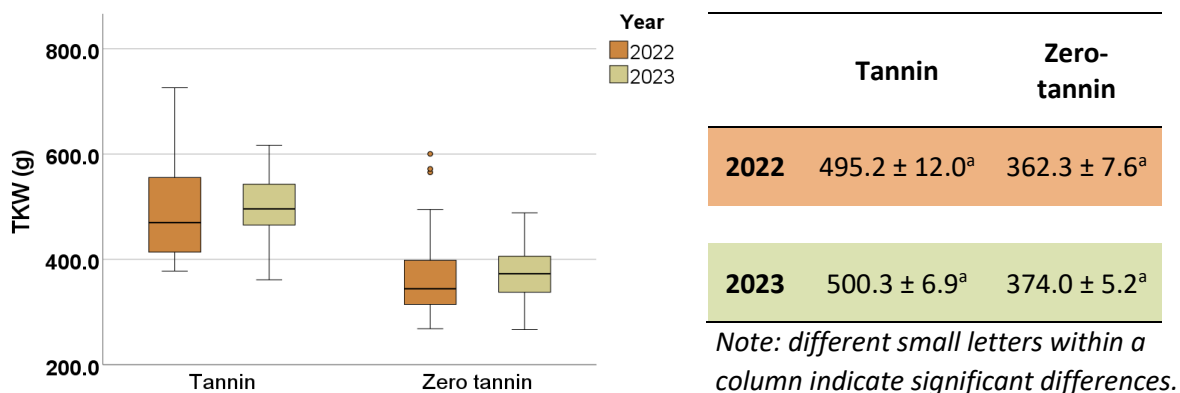
Note: \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; NS not significant.



## 2. Thousand Kernel Weight

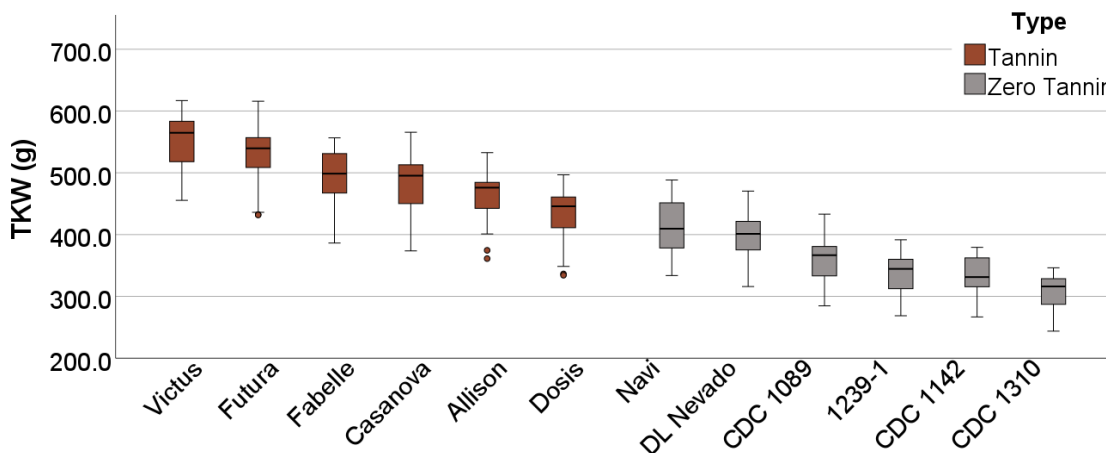
**Method:** Seed weight is an important parameter to indicate seed size and yield production. This test was conducted by weighing 300 seeds with duplicated measurements per sample, and the thousand kernel weight (TKW) was reported.

**Results: Figure 2.1. & Table 2.1.** TKW of faba beans in 2022 and 2023. Data in the table represent mean  $\pm$  one standard error. The data in the figure and table include only the varieties tested in both years; see the varieties shown in black in Table A (p. 2).



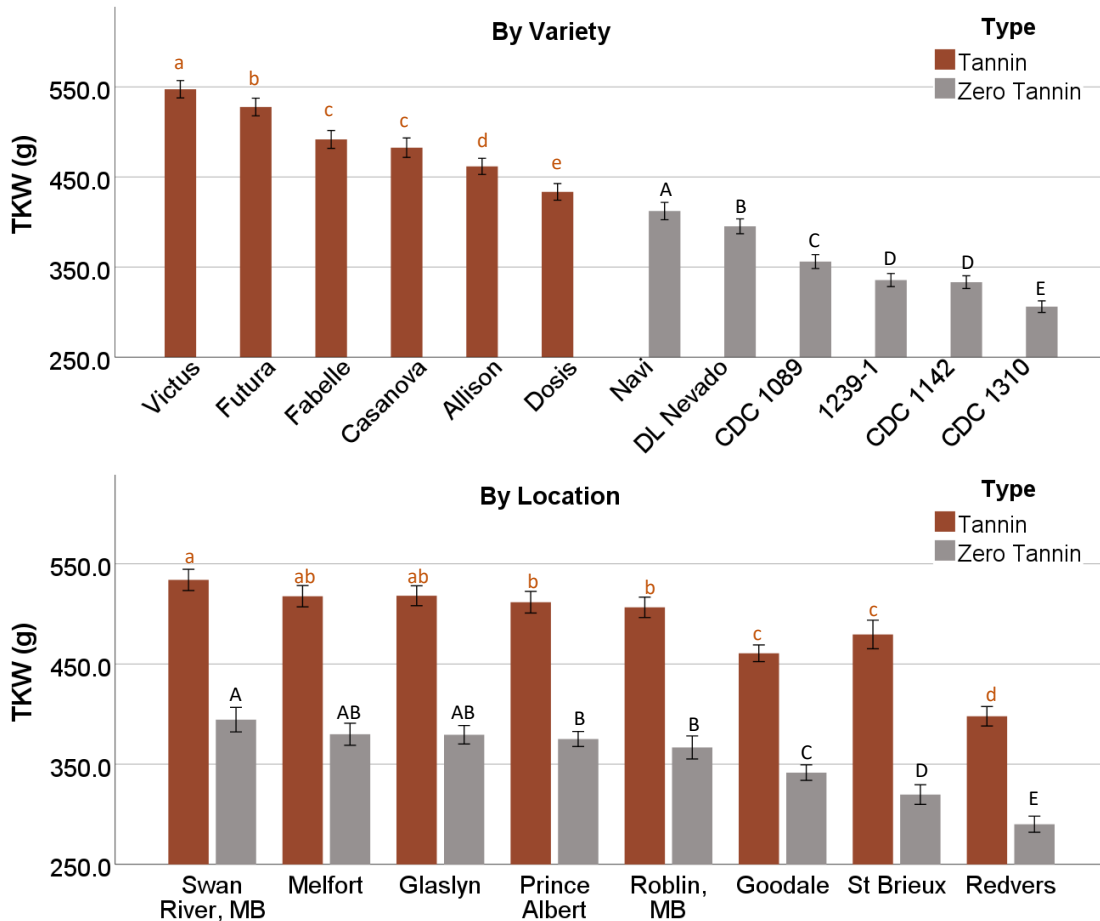
- There was no difference between both years for either types.
- Tannin type had a greater TKW than the zero-tannin.

**Figure 2.2.** Box and Whisker plot of 2023 faba beans for TKW. Results by type were reported from highest to lowest.



- TKW varied among the varieties.

**Figure 2.3.** Mean TKW of 2023 faba beans by variety (top) and by location (bottom). Each bar represents mean  $\pm$  one standard error.



Note: Small letters indicated significant differences ( $p < 0.05$ ) between tannin varieties. Capital letters indicated significant differences ( $p < 0.05$ ) between zero-tannin varieties.

- **By Variety:** Variety effect played a significant role.
  - **Tannin:** Mean TKW of Victus was 114 g higher ( $p < 0.05$ ) than Dosis.
  - **Zero Tannin:** Navi was 106 g larger than CDC 1310.
- **By Location:** TKW was similar in Swan River, Melort, Glaslyn, Prince Albert, and Roblin. Goodale and St. Brieux were lower. TKW of Redvers was the lowest.

**Table 2.2.** Effects of variety and location in 2023.

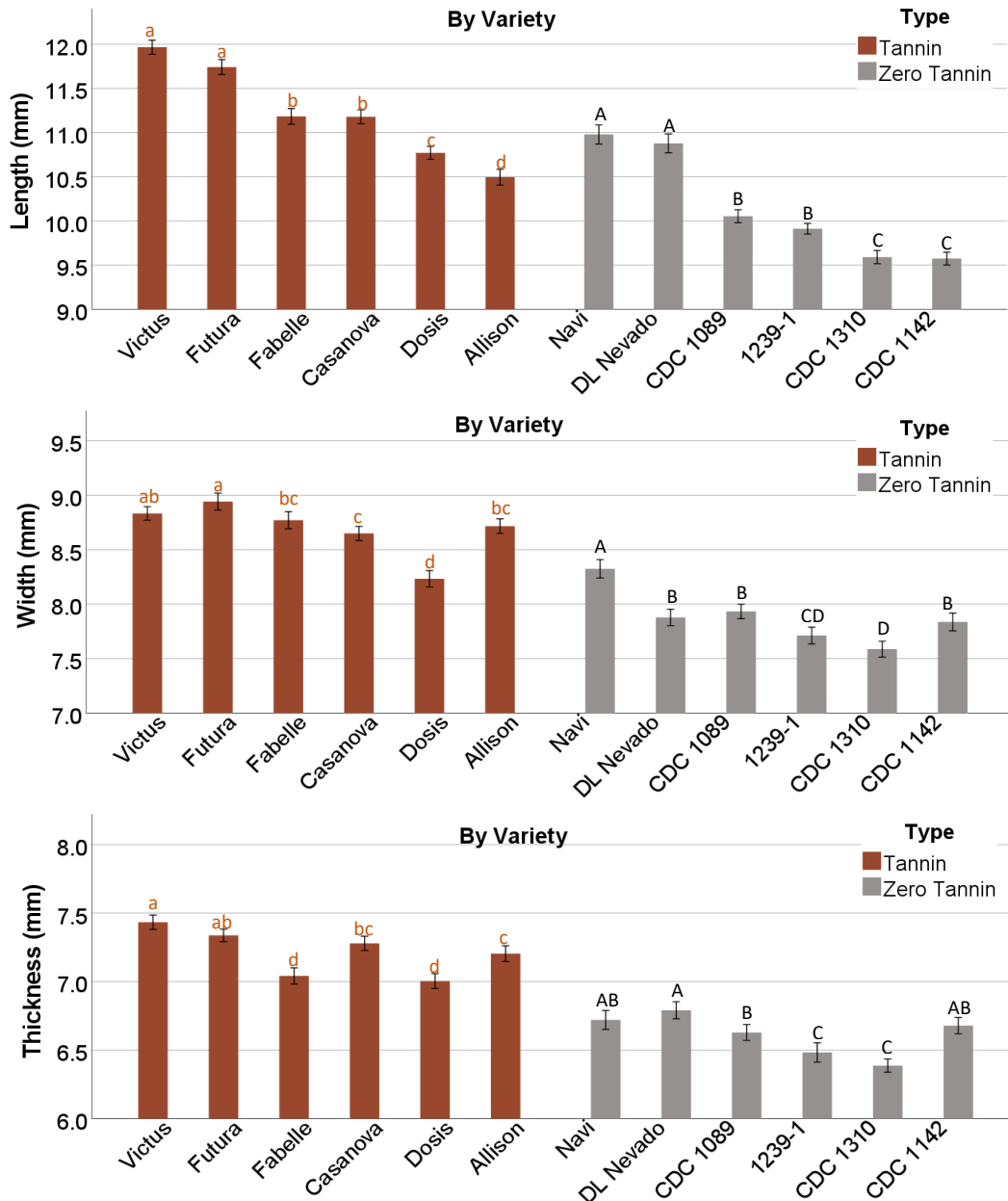
|                           | Tannin | Zero-Tannin |
|---------------------------|--------|-------------|
| <b>Variety</b>            | ***    | ***         |
| <b>Location</b>           | ***    | ***         |
| <b>Variety x Location</b> | **     | *           |

Note: \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; NS not significant.

### 3. Seed Size

**Method:** The length, width, and thickness (mm) of the faba bean seed were measured with a caliper. The mean of twenty seeds was reported.

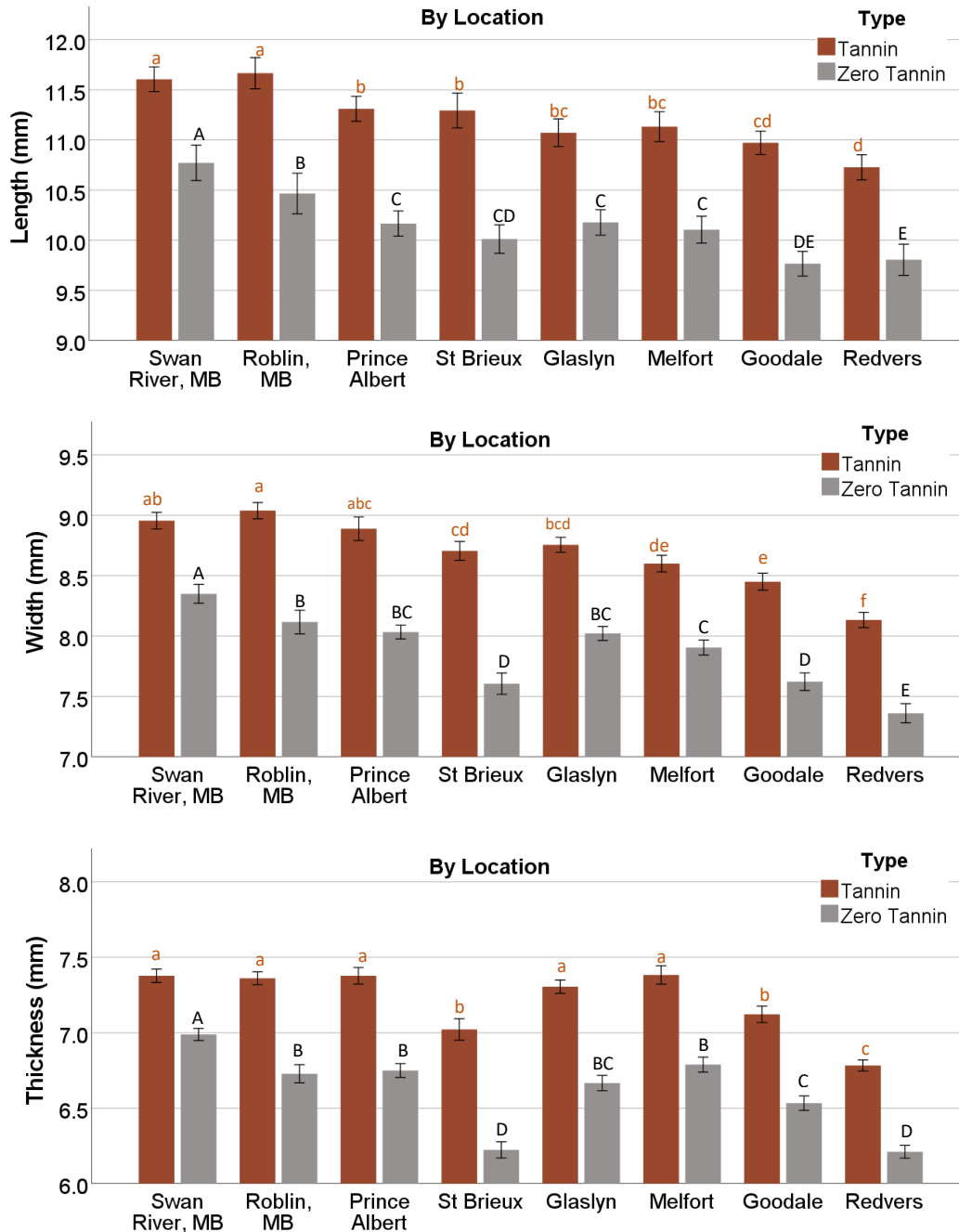
**Figure 3.1.** Mean length (mm), width (mm), thickness (mm) of 2023 faba beans by variety.



- Victus had the largest length and thickness, and the second largest width, corresponding to the largest TKW. In contrast, CDC 1310 had the smallest length, width, and thickness, contributing to the smallest TKW.

2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,  
TEI: (306) 933-7555, FAX: (306) 933-7208

**Figure 3.2.** Mean length (mm), width (mm), thickness (mm) of 2023 faba beans by location.



Note: Small letters indicated significant differences ( $p < 0.05$ ) between tannin varieties. Capital letters indicated significant differences ( $p < 0.05$ ) between zero-tannin varieties.

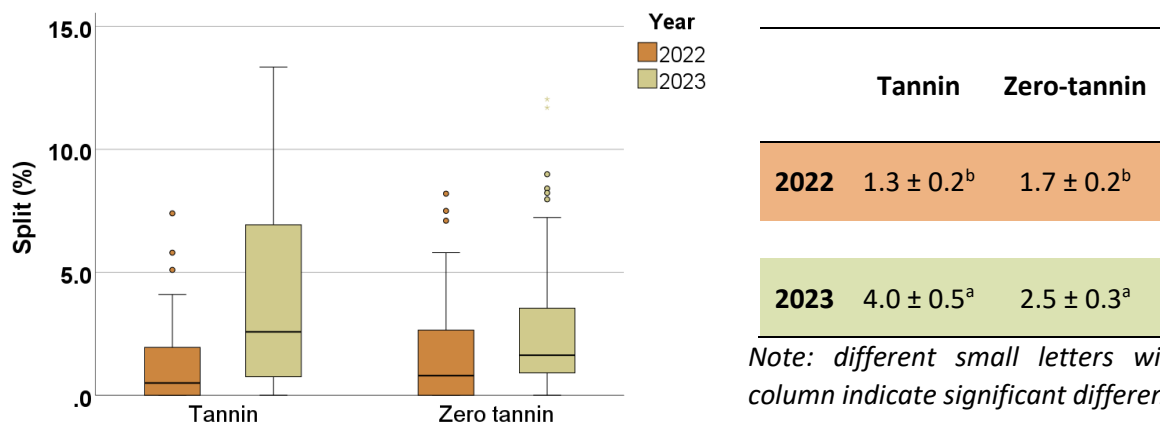
- The largest seeds were found in Swan River, while Redvers had the smallest seed size.



## 4. Split

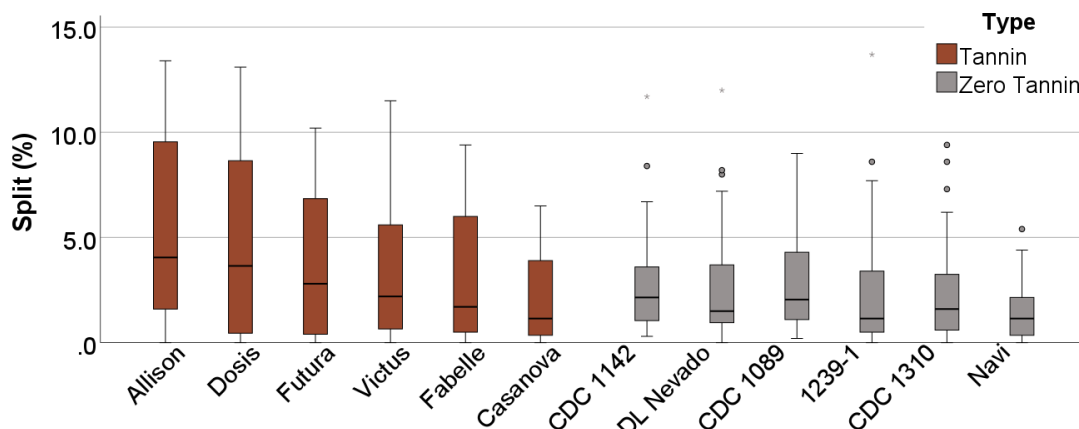
**Method:** 100 grams of each sample was used for evaluation, and damaged seeds were selected by hand. Results included splits, cracks, seed coat damage, partially missing hull, and partially missing cotyledon.

**Results: Figure 4.1. & Table 4.1.** Split faba beans in 2022 and 2023. Data in the table represent mean  $\pm$  one standard error. The data in the figure and table include only the varieties tested in both years; see the varieties shown in black in Table A (p. 2).



- There were more split seeds in 2023 ( $p < 0.05$ ).

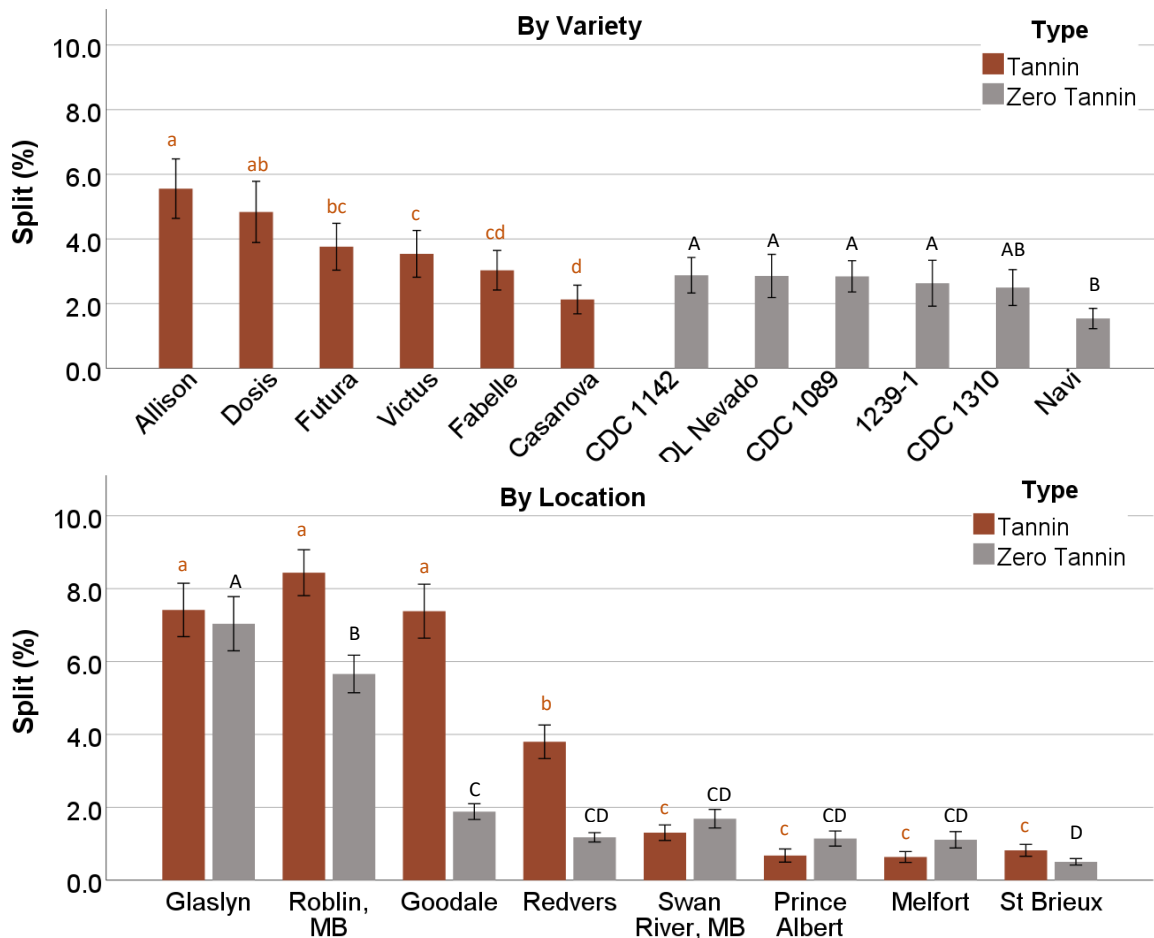
**Figure 4.2.** Box and Whisker plot of faba beans for the split in 2023. Results by type were reported from highest to lowest.



- A large variability was observed in all faba beans, especially in the tannin type.
- Casanova and Navi had the lowest split amounts in the tannin and zero tannin types, respectively.

2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,  
TEI: (306) 933-7555, FAX: (306) 933-7208

**Figure 4.3.** Mean split of 2023 faba beans by variety (top) and by location (bottom). Each bar represents mean  $\pm$  one standard error.



Note: Small letters indicated significant differences ( $p < 0.05$ ) between tannin varieties. Capital letters indicated significant differences ( $p < 0.05$ ) between zero-tannin varieties.

- **By Variety:**
  - **Tannin:** Casanova was 3.5% lower than Allison.
  - **Zero Tannin:** Navi was 1.4% lower than all others.
- **By Location:** Location effect played an significant role. Split was low (less than 2%) in Swan River, Prince Albert, Melfort, and St Brieux for both types. However, it was extremely high (over 7%) in Glaslyn, Roblin, and Goodale. Post-harvest processing is an important factor in split amount.

**Table 4.2.** Effects of variety and location.

|                           | Tannin | Zero-Tannin |
|---------------------------|--------|-------------|
| <b>Variety</b>            | ***    | **          |
| <b>Location</b>           | ***    | ***         |
| <b>Variety x Location</b> | ***    | ***         |

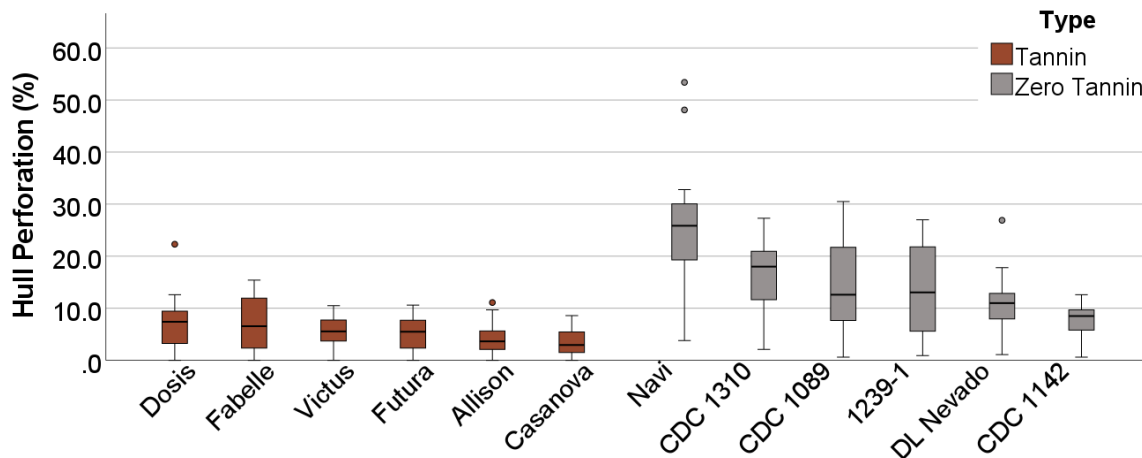
Note: \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; NS not significant.

## 5. Hull Perforation

**Method:** 100 grams of each sample was used for evaluation, and seeds with hull perforation due to disease or insects were selected by hand.

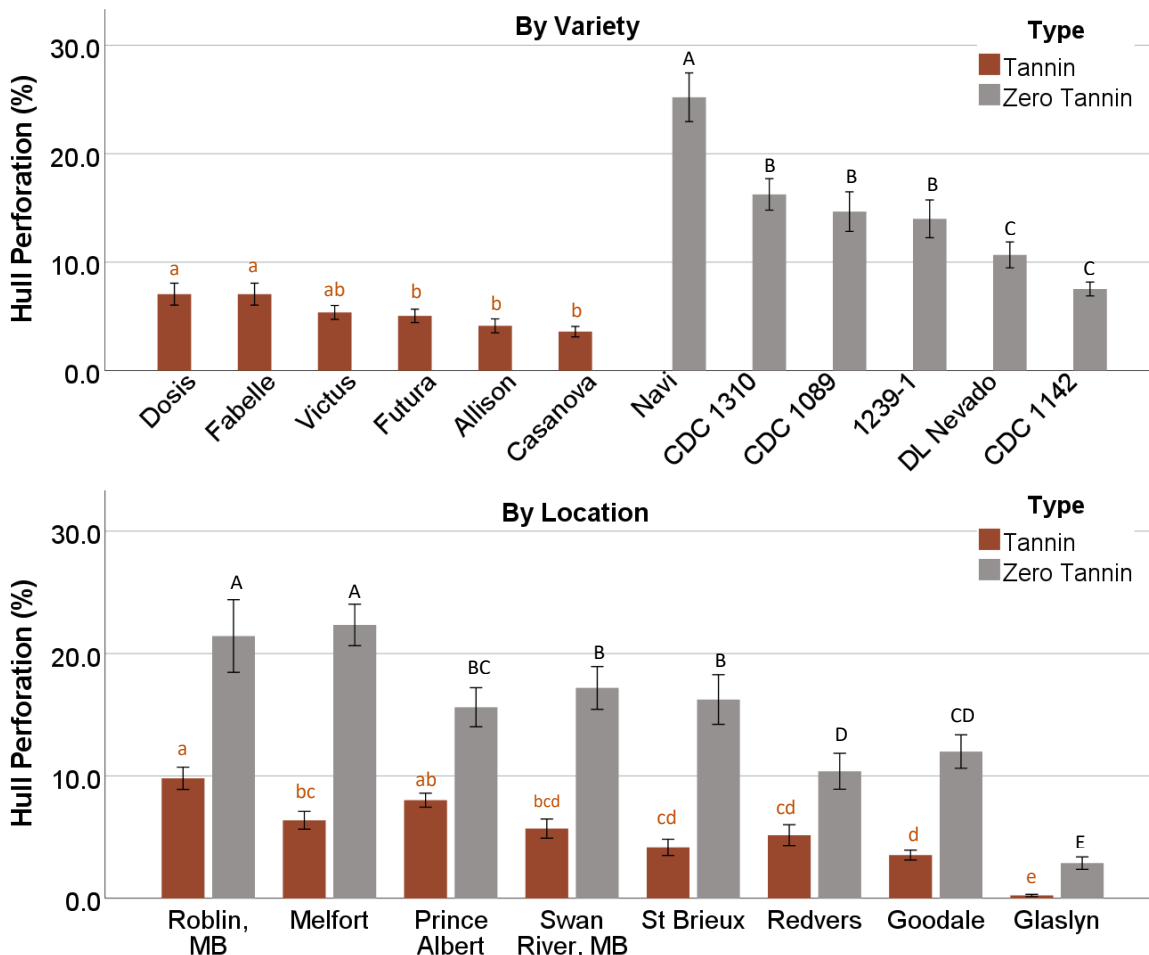
**Results:** The results of hull perforation were reported along with the other damage in 2022. Therefore, the comparison of the 2022 and 2023 averages is not provided in this section.

**Figure 5.1.** Box and Whisker plot of faba beans for the hull perforation in 2023. Results by type were reported from highest to lowest.



- Zero-tannin faba beans had a higher rate of hull perforation due to disease or insects.
- Among the tannin types, Casanova had the lowest hull perforation.

**Figure 5.2.** Mean hull perforation of 2023 faba beans by variety (top) and by location (bottom). Each bar represents mean  $\pm$  one standard error.



Note: Small letters indicated significant differences ( $p < 0.05$ ) between tannin varieties. Capital letters indicated significant differences ( $p < 0.05$ ) between zero-tannin varieties.

- **By Variety:** Overall, zero tannin is more susceptible to hull perforation due to disease and insects.
  - **Tannin:** A 3.5% difference is observed from highest to lowest.
  - **Zero Tannin:** A 17.5% difference is observed from highest to lowest.
- **By Location:** Glaslyn had the lowest hull perforation damage.

**Table 5.1.** Effects of variety and location.

|                           | Tannin | Zero-Tannin |
|---------------------------|--------|-------------|
| <b>Variety</b>            | ***    | ***         |
| <b>Location</b>           | ***    | ***         |
| <b>Variety x Location</b> | *      | ***         |

Note: \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; NS not significant.

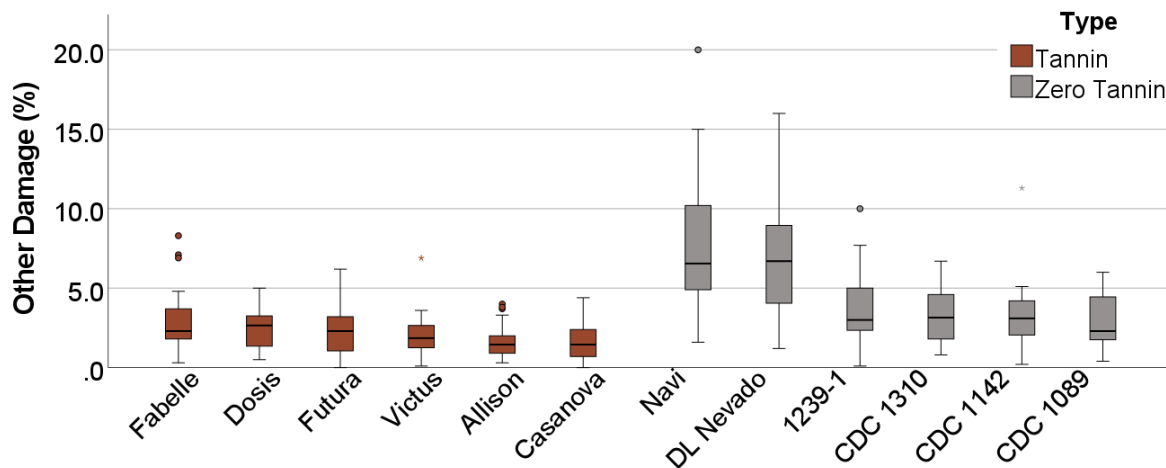


## 6. Other Damage

**Method:** 100 grams of each sample was used for evaluation, and damaged seeds were selected by hand. Other damage included sprouting, distinct immaturity, distinct deterioration or discolouration by weather or disease, insect damage, heat damage, and any other damage that affects appearance.

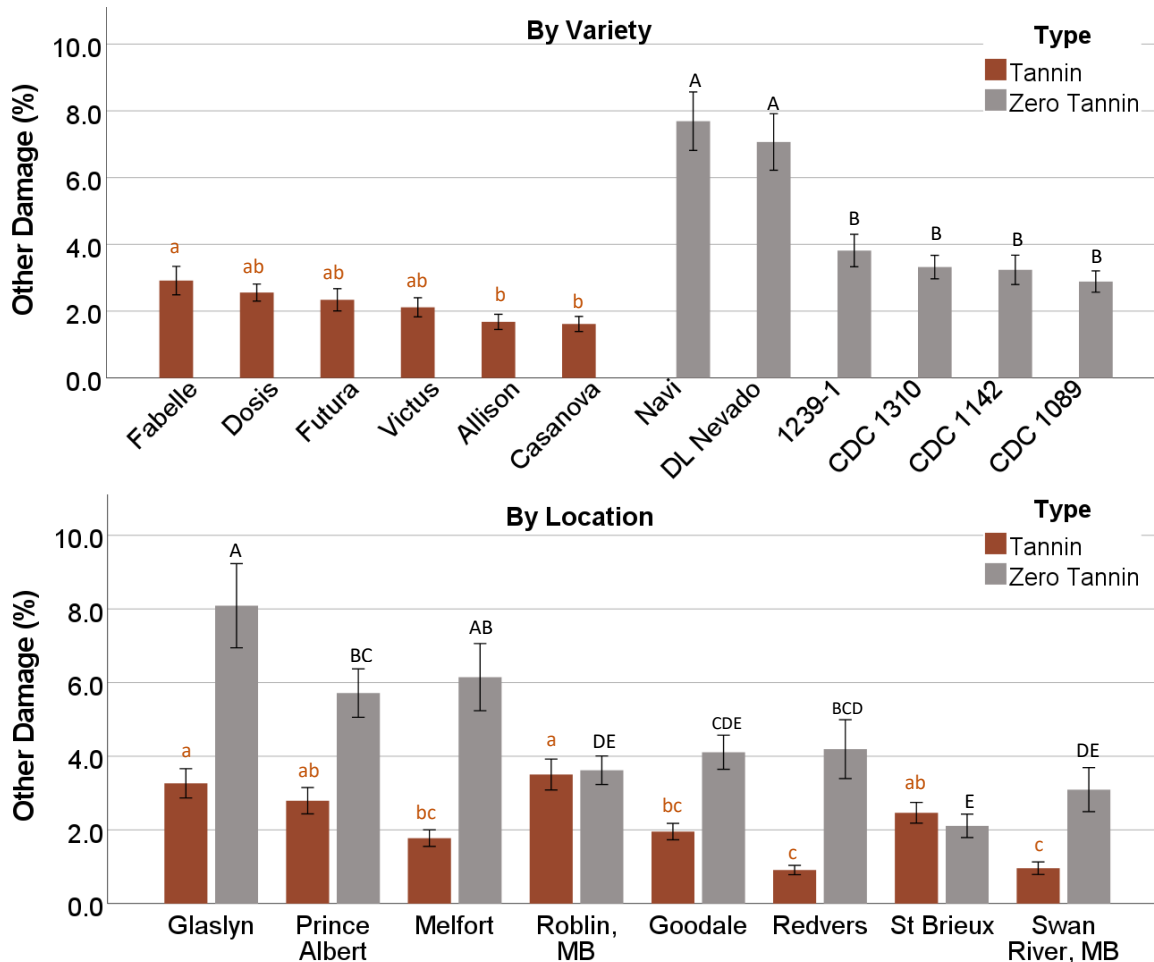
**Results:** No comparison is provided in this section, since hull perforation caused by disease or insects was reported separately in 2023 rather than being included in other damage.

**Figure 6.1.** Box and Whisker plot of faba beans for other damage in 2023. Results by type were reported from highest to lowest.



- Navi and DL Nevado had the highest other damage with very large variability.
- A high level of sprouting from water imbibition was found for Navi and DL Nevado in Glaslyn, Melfort, and Swan River. Many moldy Navi seeds were found in Redvers (data not shown).

**Figure 6.2.** Mean other damage of 2023 faba beans by variety (top) and by location (bottom). Each bar represents mean ± one standard error.



Note: Small letters indicated significant differences ( $p < 0.05$ ) between tannin varieties. Capital letters indicated significant differences ( $p < 0.05$ ) between zero-tannin varieties.

- **By Variety:** Zero tannin seeds in general had higher other damage than tannin seeds.
  - **Tannin:** A 1.3% difference is observed from highest to lowest.
  - **Zero Tannin:** A 4.8% difference is observed from highest to lowest.
- **By Location:**
  - **Tannin:** Redvers and Swan River had the lowest other damage.
  - **Zero Tannin:** All were higher than 2%.

**Table 6.1.** Effects of variety and location.

|                           | Tannin | Zero-Tannin |
|---------------------------|--------|-------------|
| <b>Variety</b>            | ***    | ***         |
| <b>Location</b>           | ***    | ***         |
| <b>Variety x Location</b> | NS     | ***         |

Note: \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; NS not significant.

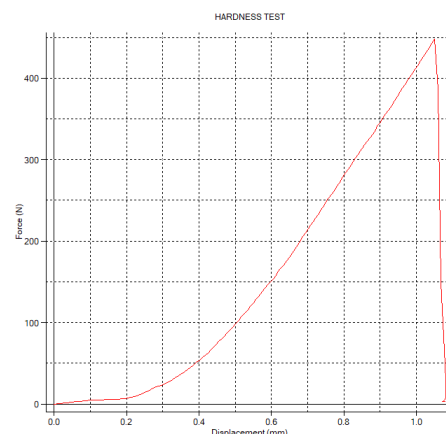
## 7. Hardness of Whole Seed

Seed hardness is an important parameter to indicate milling yield and cooking quality. Seed hardness is affected by seed size, shape, density, composition, etc.

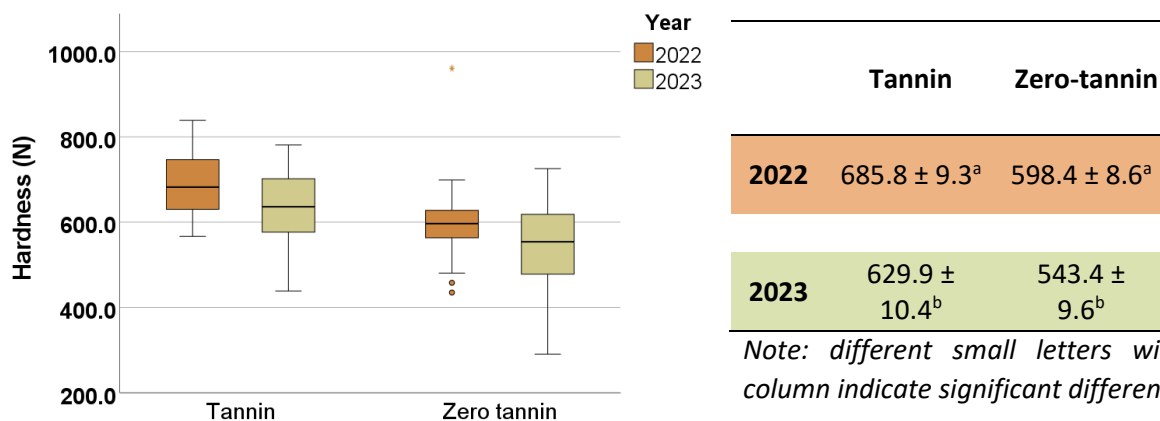
### Method:

Seed hardness was determined by measuring the force of breaking a seed using a texture analyzer (TMS-Pro, Food Technology Corporation, USA) equipped with a 2500 N load cell with a modified method from Karami et al. (2017) and Lovas-Kiss (2020)<sup>1</sup>.

In brief, a seed was placed under the 10 mm cylinder probe that was lowered with a speed of 50 mm/min. The forces to lower the probe till a seed was broken were monitored. The mean peak force (N) of 10 seeds was reported.



**Results: Figure 7.1. & Table 7.1.** Hardness of faba beans in 2022 and 2023. Data in the table represent mean  $\pm$  one standard error. The data in the figure and table include only the varieties tested in both years; see the varieties shown in black in Table A (p. 2).

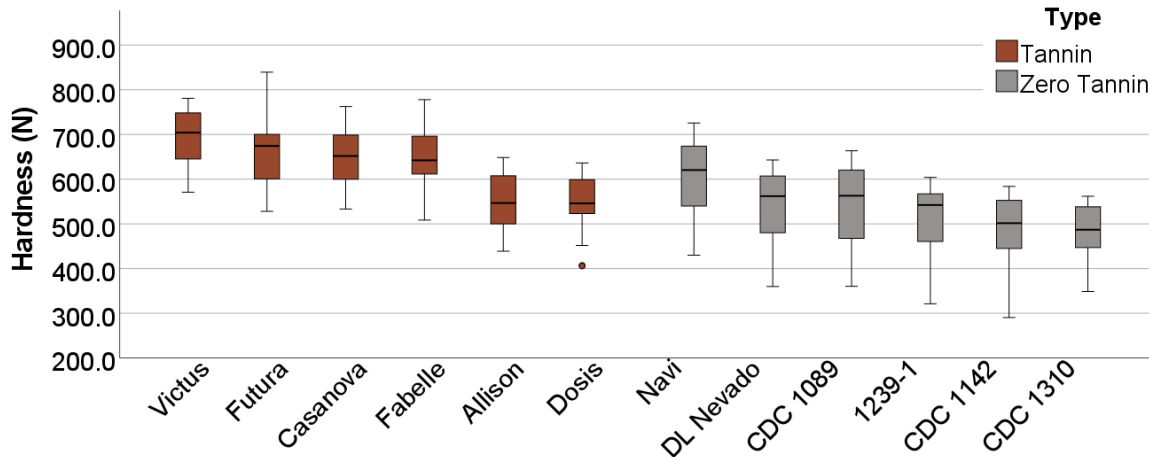


- The hardness of 2022 seeds was significantly higher than 2023. The hardness of tannin seeds was higher than the zero-tannins.

<sup>1</sup> Karami, S., Sabzalian, M. R., Rahimmalek, M., Saeidi, G., & Ghasemi, S. (2017). Interaction of seed coat color and seed hardness: An effective relationship which can be exploited to enhance resistance to the safflower fly (*Acanthiophilus helianthi*) in *Carthamus* spp. *Crop Protection*, 98, 267-275.

Lovas - Kiss, Á., Vincze, O., Kleyheeg, E., Sramkó, G., Laczkó, L., Fekete, R., ... & Green, A. J. (2020). Seed mass, hardness, and phylogeny explain the potential for endozoochory by granivorous waterbirds. *Ecology and Evolution*, 10(3), 1413-1424.

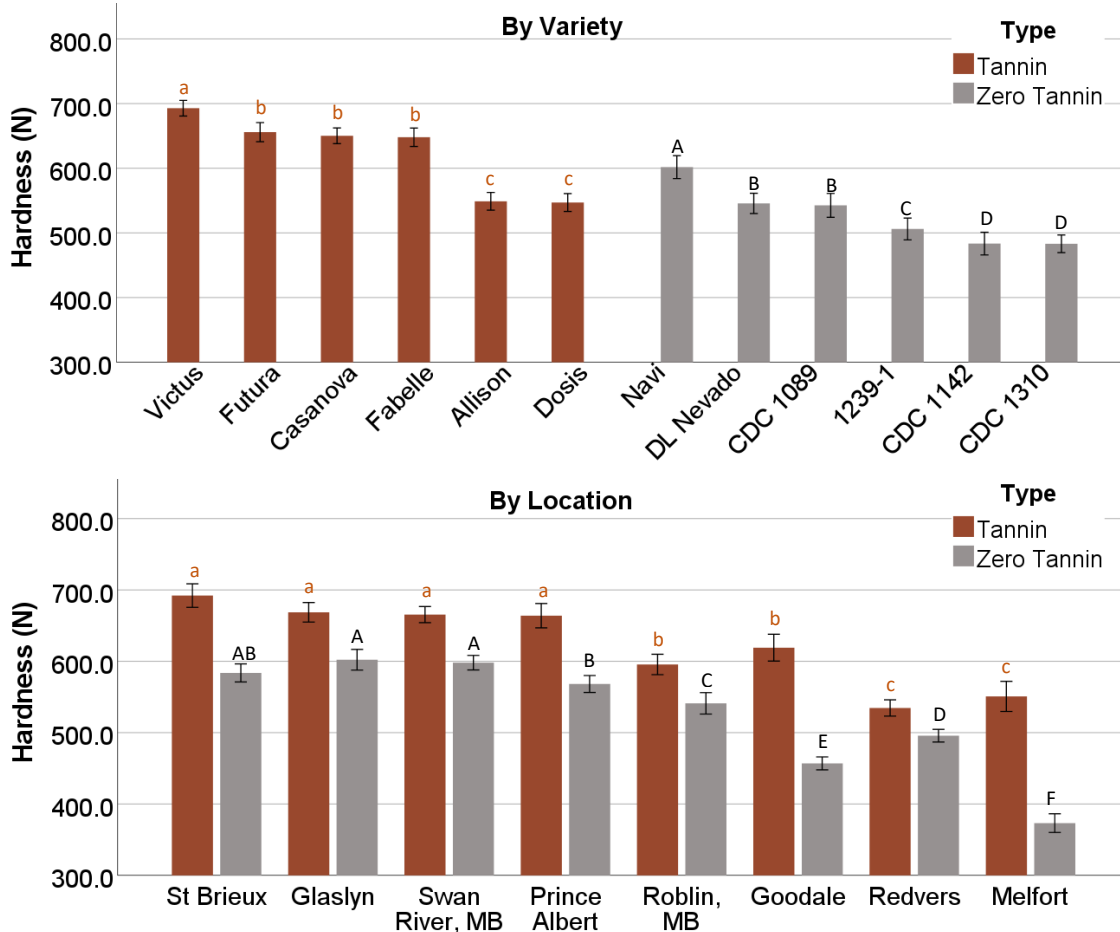
**Figure 7.2.** Box and Whisker plot of faba beans for seed hardness (N) in 2023. Results by type were reported from highest to lowest.



- For tannin types, Victus had the greatest hardness, while Allison and Dosis had the lowest.
- For zero-tannin types, Navi had the highest hardness.



**Figure 7.3.** Mean seed hardness of 2023 faba beans by variety (top) and by location (bottom). Each bar represents mean  $\pm$  one standard error.



Note: Small letters indicated significant differences ( $p < 0.05$ ) between tannin varieties. Capital letters indicated significant differences ( $p < 0.05$ ) between zero-tannin varieties.

**By Variety:**

- **Tannin:** Hardness of Victus was ~140 N higher than Allison and Dosis.
- **Zero Tannin:** Navi was ~120 N higher than CDC 1310 and 1142.

**By Location:** Location also impacted the hardness of faba beans. The zero-tannin seed hardness in Melfort was ~130 N lower than those from Glaslyn and Swan River.

**Table 7.2.** Effects of variety and location.

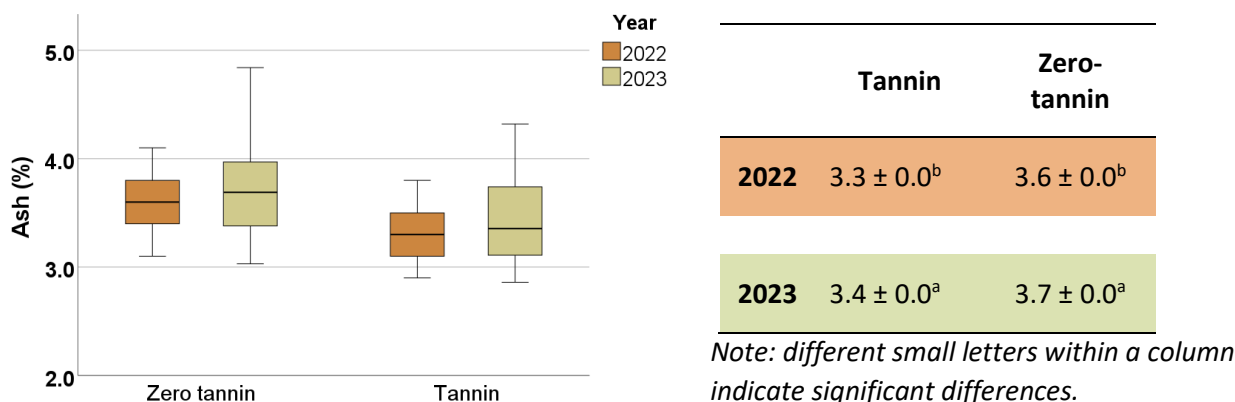
|                           | Tannin | Zero-Tannin |
|---------------------------|--------|-------------|
| <b>Variety</b>            | ***    | ***         |
| <b>Location</b>           | ***    | ***         |
| <b>Variety x Location</b> | ***    | ***         |

Note: \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; NS not significant.

## 8. Ash Content

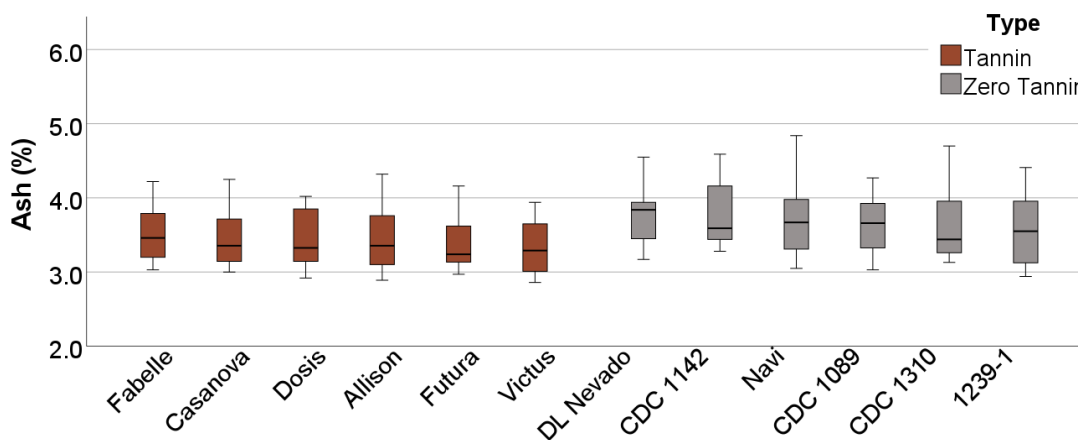
**Method:** Ash content (%) was determined using AACC 08-01.01<sup>2</sup> with modification. Samples were heated at 560°C till they turned white. Duplicated measurements were performed for each sample, and the average was reported on a dry basis (d.b.).

**Results: Figure 8.1. & Table 8.1.** Ash of faba beans in 2022 and 2023. Data in the table represent mean ± one standard error. The data in the figure and table include only the varieties tested in both years; see the varieties shown in black in Table A (p. 2).



- Ash of 2023 samples was higher than those in 2022.

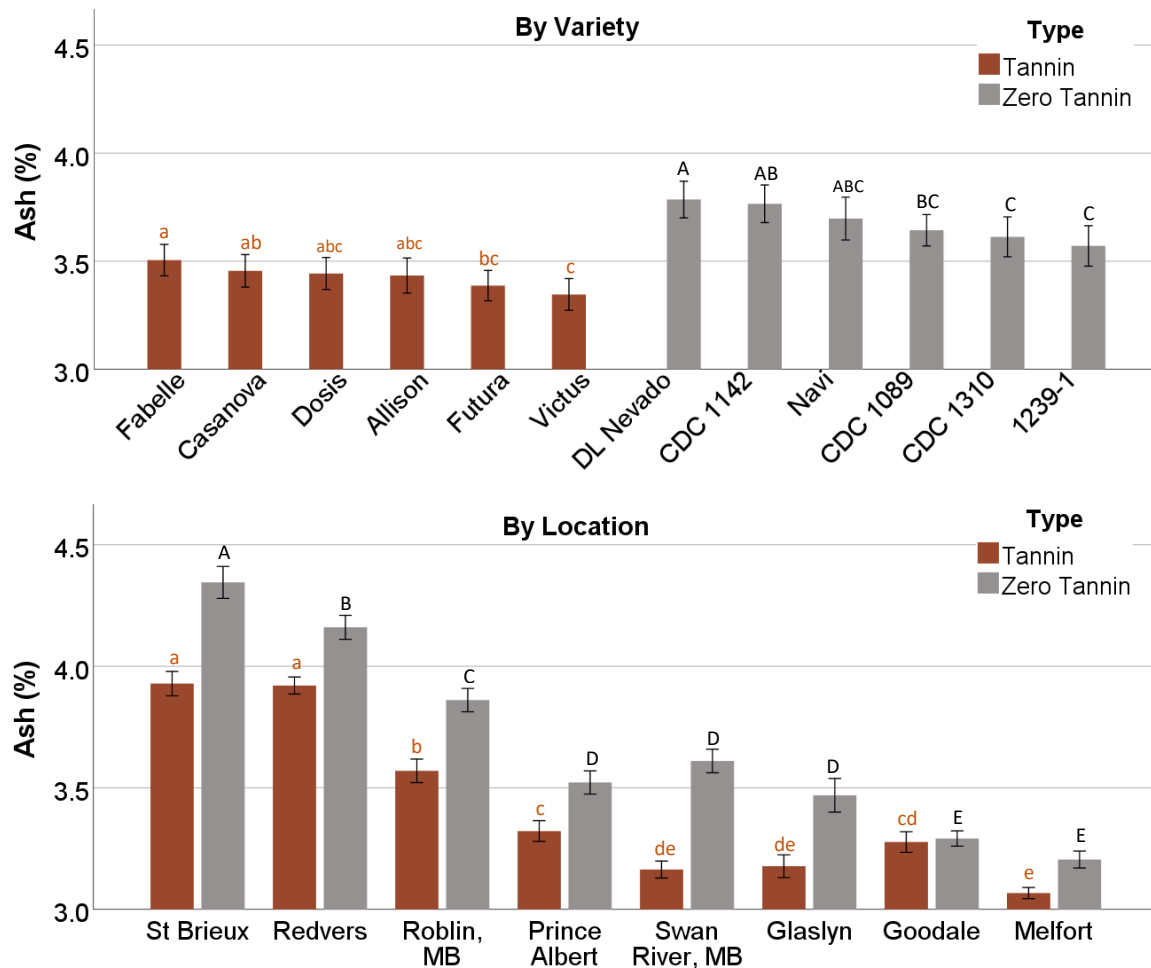
**Figure 8.2.** Box and Whisker plot of faba beans for ash content in 2023. Results by type were reported from highest to lowest.



- Overall, the zero-tannin types had a higher ash content than the tannin types.

<sup>2</sup> AACC (1999). American Association of Cereal Chemists International. Approved methods of analysis (11th ed.). The Saint Pauls Association: Saint Paul, MN.

**Figure 8.3.** Mean ash of 2023 faba beans by variety (top) and by location (bottom). Each bar represents mean ± one standard error.



Note: Small letters indicated significant differences ( $p < 0.05$ ) between tannin varieties. Capital letters indicated significant differences ( $p < 0.05$ ) between zero-tannin varieties.

- **By Variety:**
  - **Tannin:** A 0.2% difference was found from highest to lowest.
  - **Zero Tannin:** A 0.2% difference was found from highest to lowest.
- **By Location:** Location effect played a role.
  - **Tannin:** A 0.9% difference was found from highest to lowest.
  - **Zero Tannin:** A 1.1% difference was found from highest to lowest.

**Table 8.2.** Effects of variety and location.

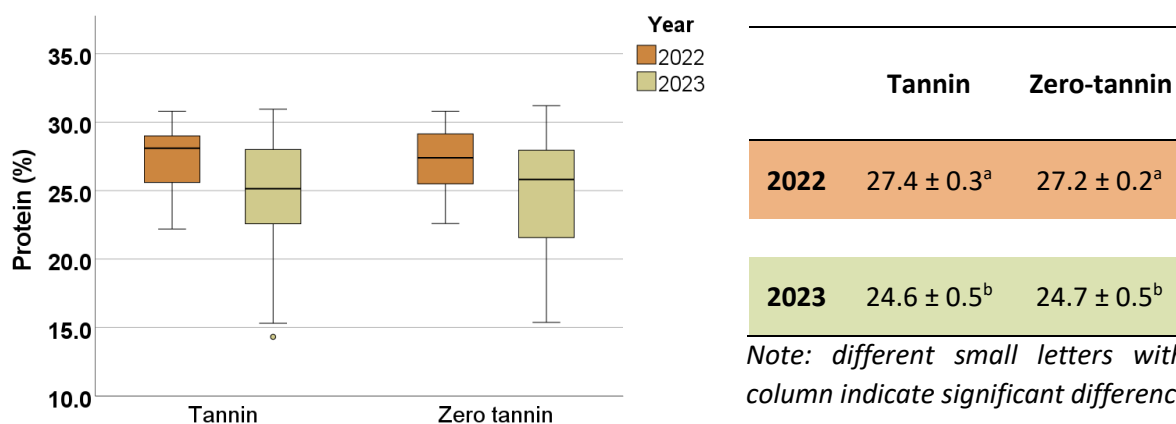
|                           | Tannin | Zero-Tannin |
|---------------------------|--------|-------------|
| <b>Variety</b>            | ***    | ***         |
| <b>Location</b>           | ***    | ***         |
| <b>Variety x Location</b> | ***    | ***         |

Note: \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; NS not significant.

## 9. Protein Content

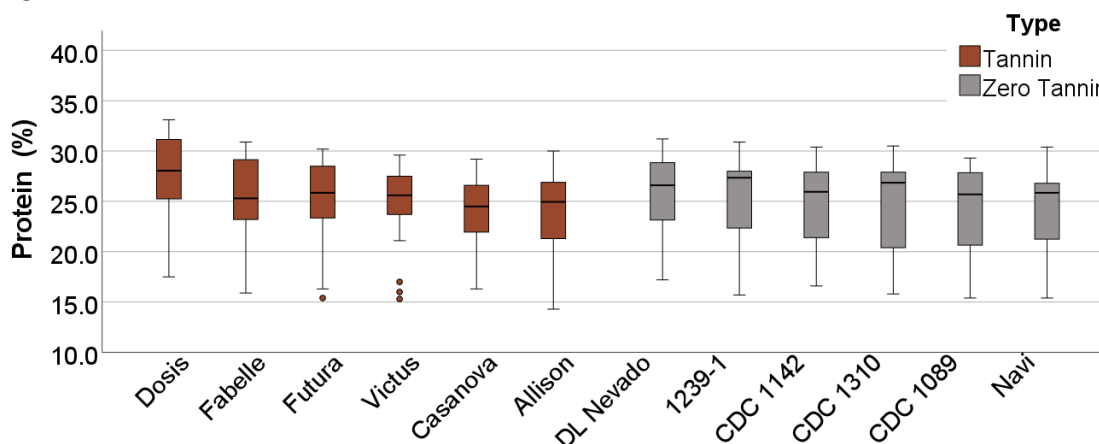
**Method:** The protein content (%) of each flour was determined through AACC 46-30<sup>2</sup> using the combustion method through a Rapid N Exceed (Elementar, USA). Duplicated measurements were performed for each sample, and the average was reported on a dry basis (d.b.).

**Results: Figure 9.1. & Table 9.1.** Protein of faba beans in 2022 and 2023. Data in the table represent mean  $\pm$  one standard error. The data in the figure and table include only the varieties tested in both years; see the varieties shown in black in Table A (p. 2).



- The 2023 faba beans had lower protein content than the 2022 samples ( $p < 0.05$ ).

**Figure 9.2.** Box and Whisker plot of faba beans for protein content in 2023. Results by type were reported from highest to lowest.

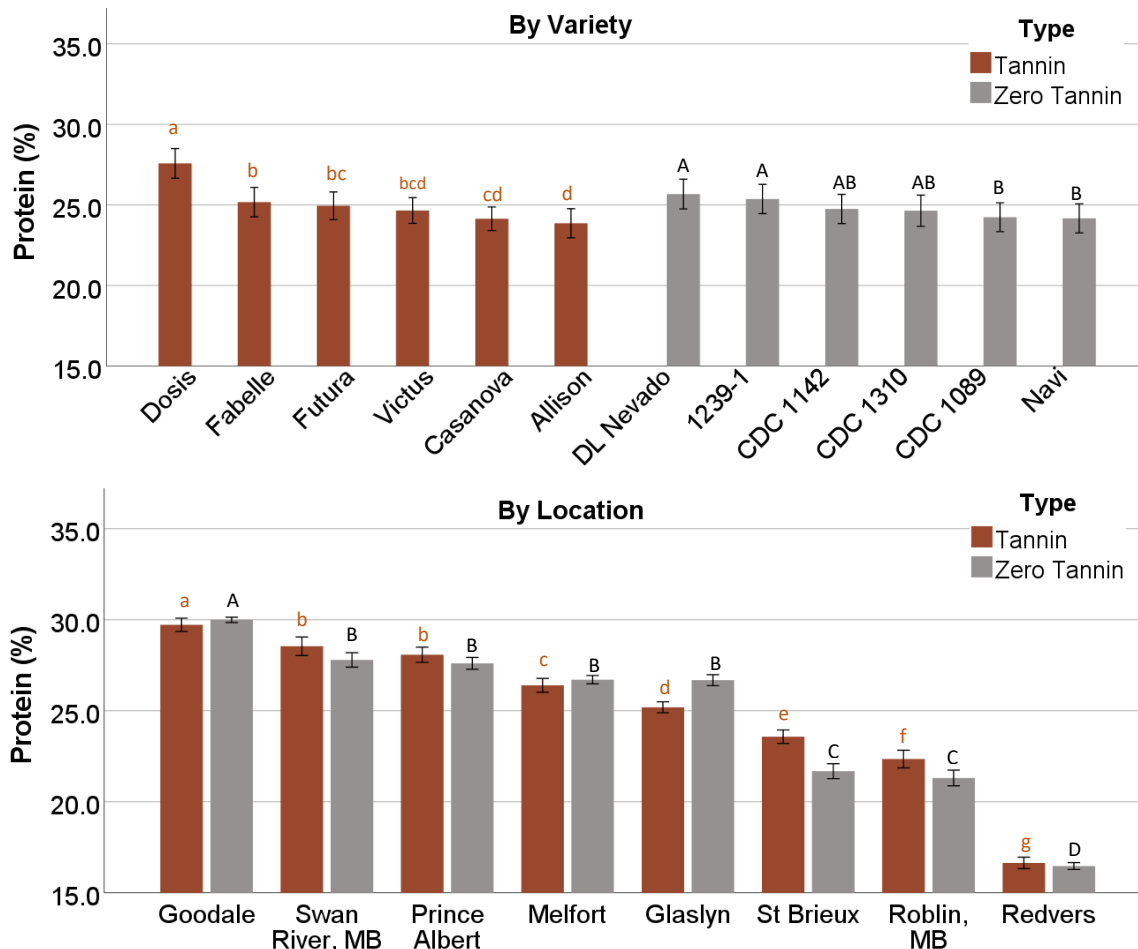


- A large variability in protein content was found across all varieties.

<sup>2</sup> AACC (1999). American Association of Cereal Chemists International. Approved methods of analysis (11th ed.). The Saint Pauls Association: Saint Paul, MN.



**Figure 9.3.** Mean protein of 2023 faba beans by variety (top) and by location (bottom). Each bar represents mean  $\pm$  one standard error.



Note: Small letters indicated significant differences ( $p < 0.05$ ) between tannin varieties. Capital letters indicated significant differences ( $p < 0.05$ ) between zero-tannin varieties.

- **By Variety:**
  - **Tannin:** Dosis (highest) was 3.7% higher than Allison (lowest).
  - **Zero Tannin:** A 1.5% in difference was found from highest to lowest was observed.
- **By Location:** Location effect played a significant role.
  - Redvers (both types) was about 5.5% lower than Roblin (second lowest) and 13% lower than Goodale (highest) for both types.

**Table 9.2.** Effects of variety and location.

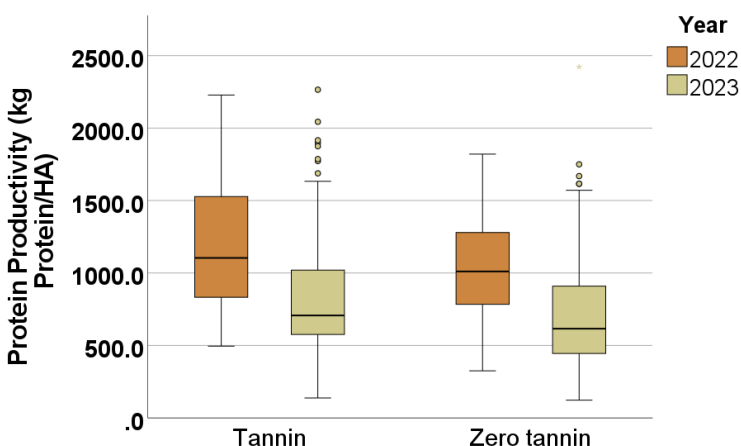
|                           | Tannin | Zero-Tannin |
|---------------------------|--------|-------------|
| <b>Variety</b>            | ***    | ***         |
| <b>Location</b>           | ***    | ***         |
| <b>Variety x Location</b> | NS     | NS          |

Note: \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; NS not significant.

## 10. Protein Productivity

**Method:** Protein productivity (kg protein/HA), which is calculated using yield (kg/HA) multiplied by protein content (%), refers to the amount of protein produced per unit of land. It evaluates how much protein is being harvested from a given area.

**Results: Figure 10.1. & Table 10.1.** Protein productivity of faba beans in 2022 and 2023. Data in the table represent mean  $\pm$  one standard error. The data in the figure and table include only the varieties tested in both years; see the varieties shown in black in Table A (p. 2).

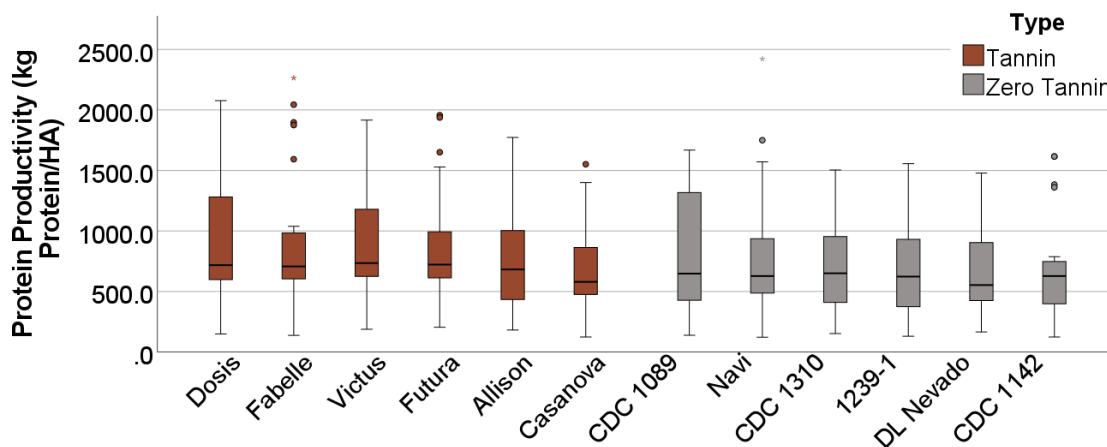


|             | Tannin                         | Zero-tannin                    |
|-------------|--------------------------------|--------------------------------|
| <b>2022</b> | 1146.6 $\pm$ 57.5 <sup>a</sup> | 1011.7 $\pm$ 41.7 <sup>a</sup> |
| <b>2023</b> | 853.9 $\pm$ 60.9 <sup>b</sup>  | 738.6 $\pm$ 47.4 <sup>b</sup>  |

*Note: different small letters within a column indicate significant differences.*

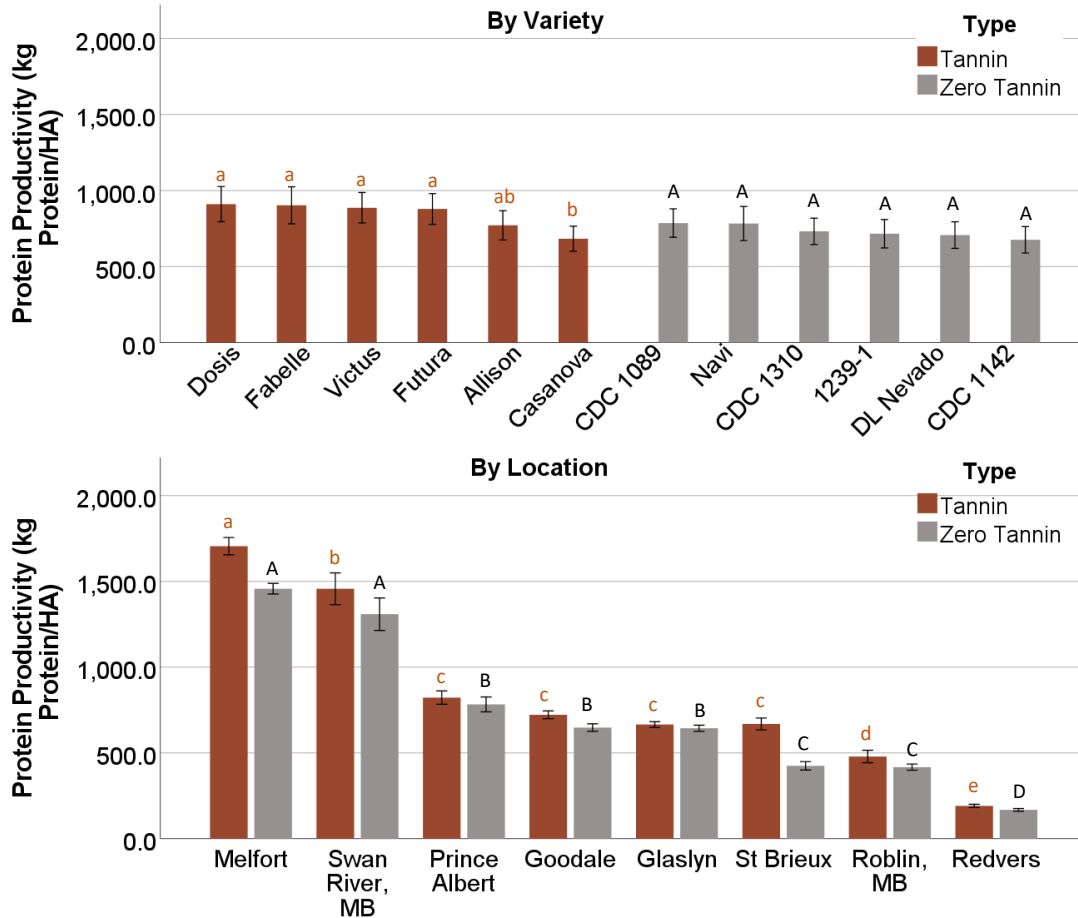
- Protein productivity of the 2023 faba beans was significantly lower than the 2022 samples ( $p < 0.05$ ).

**Figure 10.2.** Box and Whisker plot of faba beans for protein productivity in 2023. Results by type were reported from highest to lowest.



- A large variability in protein productivity was found across all varieties.

**Figure 10.3.** Mean protein productivity of 2023 faba beans by variety (top) and by location (bottom). Each bar represents mean  $\pm$  one standard error.



Note: Small letters indicated significant differences ( $p < 0.05$ ) between tannin varieties. Capital letters indicated significant differences ( $p < 0.05$ ) between zero-tannin varieties.

- **By Variety:**
  - **Tannin:** Dosis (highest) was 228 kg protein/HA higher than Casanova (lowest).
  - **Zero Tannin:** No significant differences were found among the six varieties.
- **By Location:** Location effect played a significant role.
  - Melfort and Swan River had high protein productivity due to their high yield and relatively high protein content.
  - In contrast, Redvers had the lowest yield and protein content, resulting in the lowest protein productivity.

**Table 10.2.** Effects of variety and location.

|                           | Tannin | Zero-Tannin |
|---------------------------|--------|-------------|
| <b>Variety</b>            | ***    | NS          |
| <b>Location</b>           | ***    | ***         |
| <b>Variety x Location</b> | NS     | NS          |

Note: \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; NS not significant.

## 11. Colour

**Method:** The absolute colour of each flour was determined using the Konica Minolta CR-400 Chroma meter, where  $L^*$ ,  $a^*$ , and  $b^*$  values were reported. Three measurements were made for each sample, and the mean value was reported.

- $L^*$  (**lightness**): white (100) to black (0)
- $a^*$ : red (+) to green (-)
- $b^*$ : yellow (+) to blue (-)

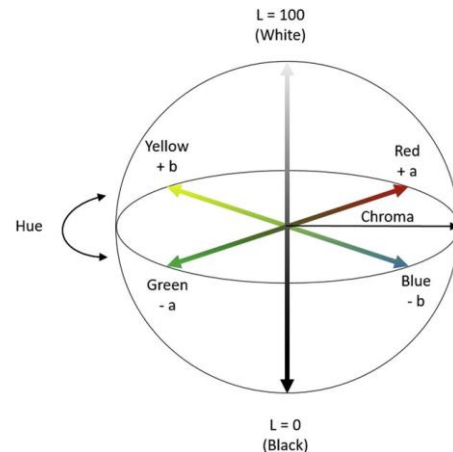
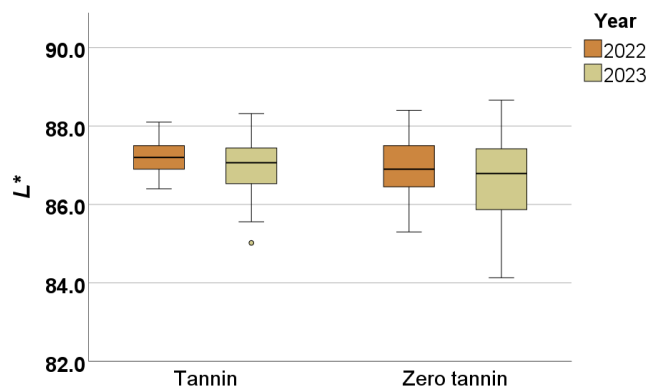


Figure 11.1. The CIELAB color spacediagram<sup>3</sup>.

### Results:

- 1)  $L^*$  (**lightness**): white (100) to black (0)

**Figure 11.2. & Table 11.1** Lightness of faba bean flours in 2022 and 2023. Data in the table represent mean  $\pm$  one standard error. The data in the figure and table include only the varieties tested in both years; see the varieties shown in black in Table A (p. 2).



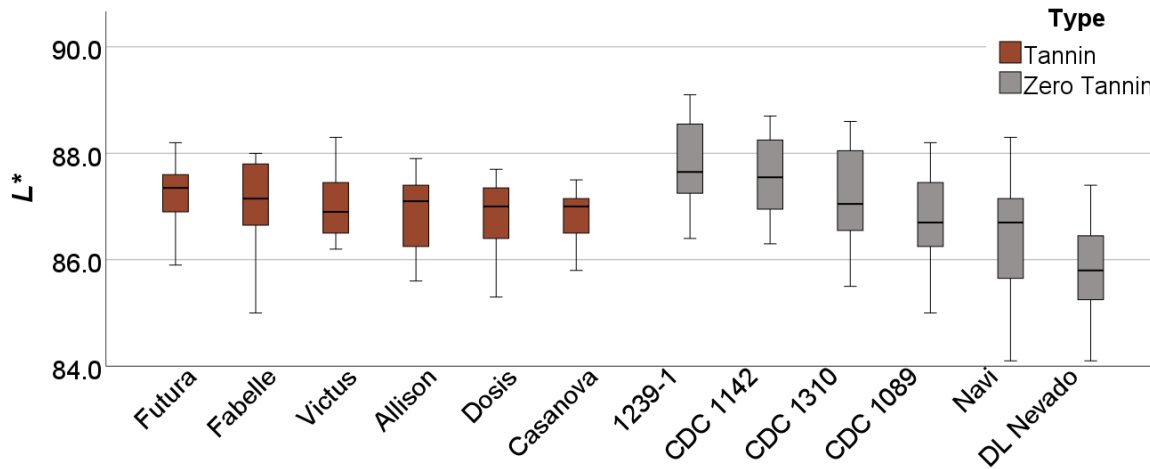
|             | Tannin                      | Zero-tannin                 |
|-------------|-----------------------------|-----------------------------|
| <b>2022</b> | 87.2 $\pm$ 0.0 <sup>a</sup> | 86.9 $\pm$ 0.1 <sup>a</sup> |
| <b>2023</b> | 87.0 $\pm$ 0.1 <sup>b</sup> | 86.7 $\pm$ 0.1 <sup>a</sup> |

Note: different small letters within a column indicate significant differences.

- Greater variability was found in 2023 samples.

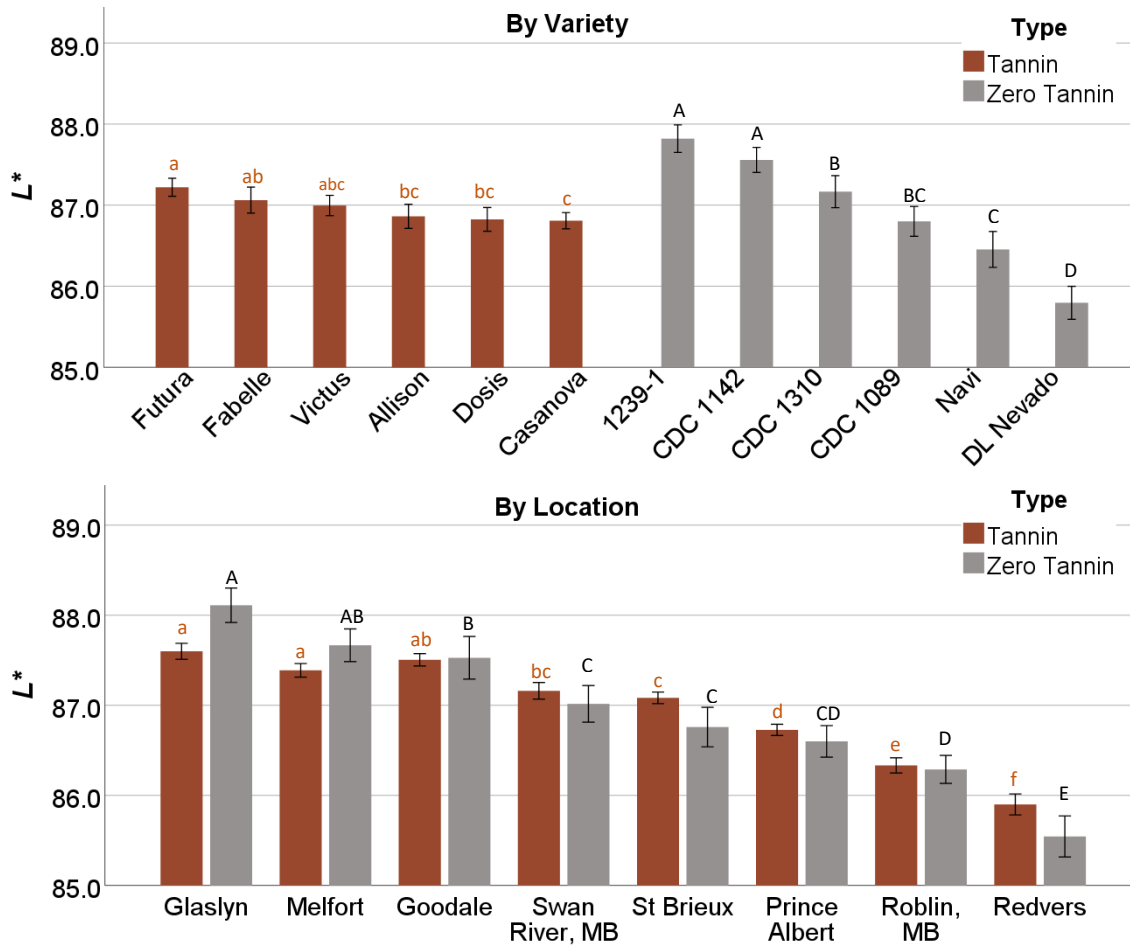
<sup>3</sup> Ly, B. C. K., Dyer, E. B., Feig, J. L., Chien, A. L., & Del Bino, S. (2020). Research techniques made simple: cutaneous colorimetry: a reliable technique for objective skin color measurement. *Journal of Investigative Dermatology*, 140(1), 3-12.

**Figure 11.3.** Box and Whisker plot of 2023 faba beans for lightness. Results by type were reported from highest to lowest.



- A greater difference within the zero tanin type was found.

**Figure 11.4.** Mean lightness of 2023 faba beans by variety (top) and by location (bottom). Each bar represents mean  $\pm$  one standard error.



Note: Small letters indicated significant differences ( $p < 0.05$ ) between tannin varieties. Capital letters indicated significant differences ( $p < 0.05$ ) between zero-tannin varieties.

- **By Variety:**
  - **Tannin:** Only a 0.4-unit difference was found from highest to lowest.
  - **Zero Tannin:** DL Nevado had the lowest lightness, which might be attributed to the darker seed coat color.
- **By Location:** Lightness also varied between locations, where the lowest lightness was found in Redvers for both types.

**Table 11.2.** Effects of variety and location.

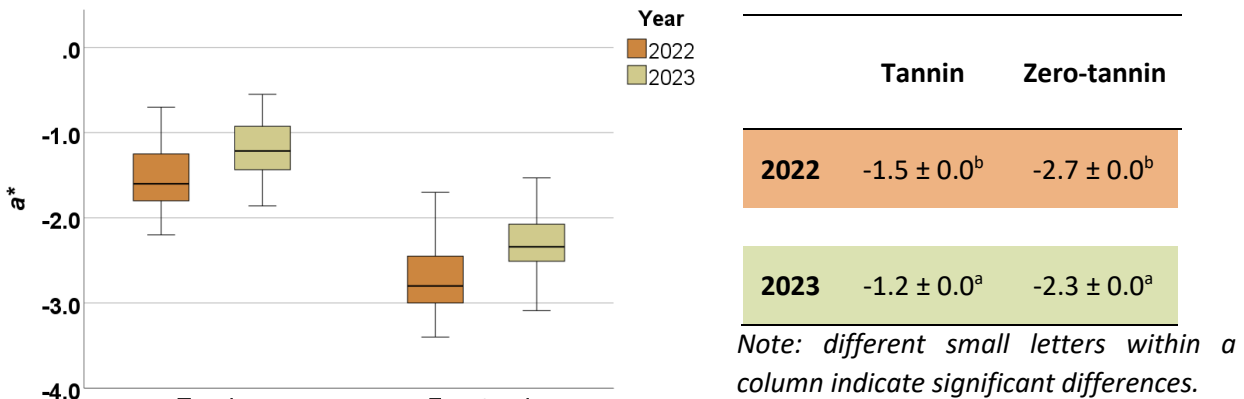
|                           | Tannin | Zero-Tannin |
|---------------------------|--------|-------------|
| <b>Variety</b>            | ***    | ***         |
| <b>Location</b>           | ***    | ***         |
| <b>Variety x Location</b> | **     | *           |

Note: \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; NS not significant.



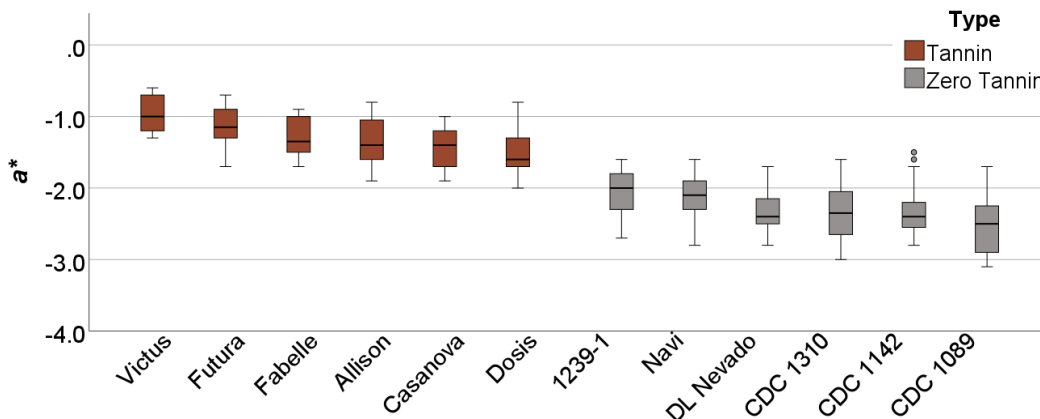
2)  $a^*$ : red (+) to green (-)

**Figure 11.5. & Table 11.3.**  $a^*$  values of faba bean flours in 2022 and 2023. Data in the table represent mean  $\pm$  one standard error. The data in the figure and table include only the varieties tested in both years; see the varieties shown in black in Table A (p. 2).



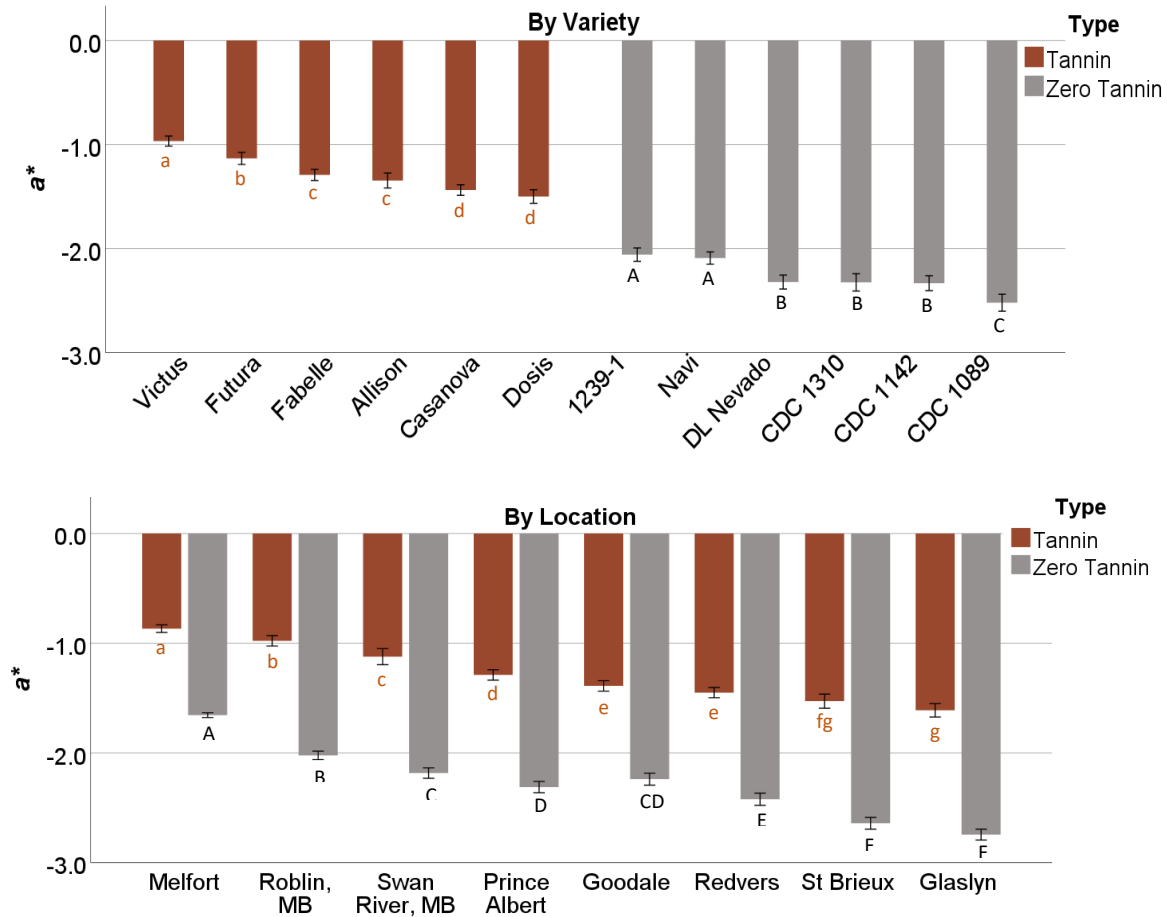
- The 2023 samples had a lower greenness.

**Figure 11.6.** Box and Whisker plot of 2023 faba beans for  $a^*$  values. Results by type were reported from highest to lowest.



- The zero-tannin type had greater greenness than the tannin type.

**Figure 11.7.** Mean  $a^*$  of 2023 faba beans by variety (top) and by location (bottom). Each bar represents mean  $\pm$  one standard error.



Note: Small letters indicated significant differences ( $p < 0.05$ ) between tannin varieties. Capital letters indicated significant differences ( $p < 0.05$ ) between zero-tannin varieties.

- **By Variety:**
  - **Tannin:** ranged from -1.5 to -1.0.
  - **Zero Tannin:** ranged from -2.5 to -2.1.
- **By Location:** Location played a role in both tannin and zero tannin types.

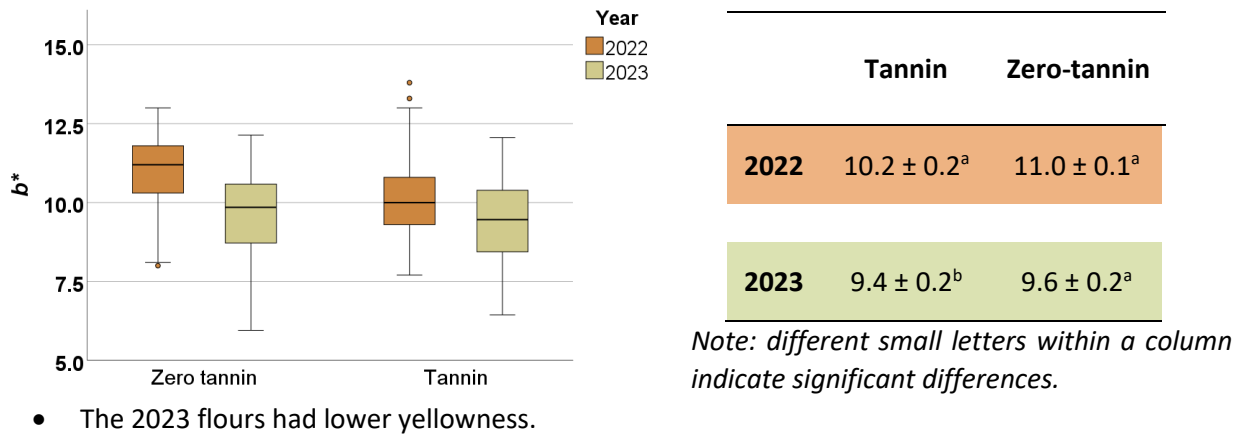
**Table 11.4.** Effects of variety and location.

|                           | Tannin | Zero-Tannin |
|---------------------------|--------|-------------|
| <b>Variety</b>            | ***    | ***         |
| <b>Location</b>           | ***    | ***         |
| <b>Variety x Location</b> | ***    | ***         |

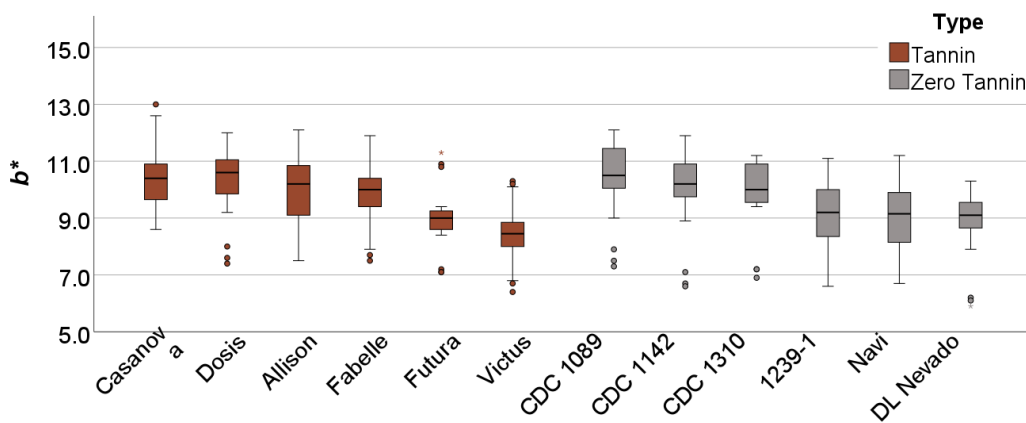
Note: \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; NS not significant.

4) **b\***: yellow (+) to blue (-)

**Figure 11.8. & Table 11.5.** *b\** values of faba bean flours in 2022 and 2023. Data in the table represent mean  $\pm$  one standard error. The data in the figure and table include only the varieties tested in both years; see the varieties shown in black in Table A (p. 2).

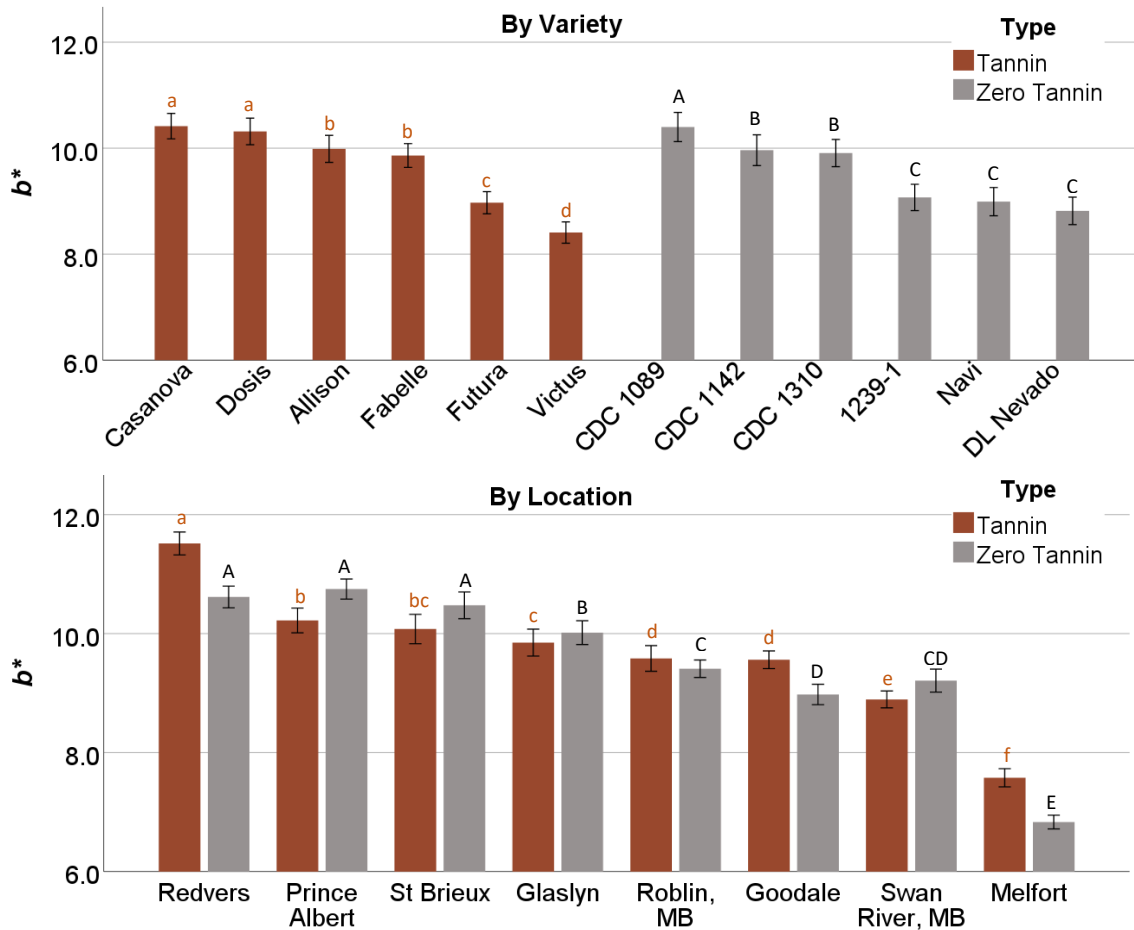


**Figure 11.9.** Box and Whisker plot of 2023 faba beans for *b\** values. Results by type were reported from highest to lowest.



- Outliers and extreme outliers were present in the 2023 samples.

**Figure 11.10.** Mean  $b^*$  of faba beans by variety (top) and by location (bottom). Each bar represents mean  $\pm$  one standard error.



Note: Small letters indicated significant differences ( $p < 0.05$ ) between tannin varieties. Capital letters indicated significant differences ( $p < 0.05$ ) between zero-tannin varieties.

- **By Variety:**
  - **Tannin:** A difference of 2 units was found from highest to lowest.
  - **Zero Tannin:** CDC 1089 was about 1.5 units higher than line 1239-1, Navi, and DL Nevado.
- **By Location:** Location played a role in both tannin and zero tannin types. Yellowness of both seed types from Melfort was 4 units lower than Redvers.

**Table 11.6.** Effects of variety and location.

|                           | Tannin | Zero-Tannin |
|---------------------------|--------|-------------|
| <b>Variety</b>            | ***    | ***         |
| <b>Location</b>           | ***    | ***         |
| <b>Variety x Location</b> | ***    | ***         |

Note: \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; NS not significant.

## **ACKNOWLEDGEMENTS**

We would like to express our sincere thanks to the Saskatchewan Pulse Growers for financially supporting this program.

### **Contact information:**

Lindsay (Yingxin) Wang, Ph.D.

Manager, Food Crop Quality  
Saskatchewan Food Industry Development Centre Inc. (Food Centre)  
2335 Schuyler Street, Saskatoon, SK, S7M 5V1, Canada  
Direct: (306) 964-1819  
E-mail: [lwang@foodcentre.sk.ca](mailto:lwang@foodcentre.sk.ca)

Mehmet Tulbek, Ph.D.

President  
Saskatchewan Food Industry Development Centre Inc. (Food Centre)  
2335 Schuyler Street, Saskatoon, SK, S7M 5V1, Canada  
Direct: (306) 933-7175  
Fax: (306) 933-7208  
Main office: (306) 933-7555  
E-mail: [mtulbek@foodcentre.sk.ca](mailto:mtulbek@foodcentre.sk.ca)