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Research Update 678

Lentil Storage

(Funded by: Agriculture Development Fund)[1]

INTRODUCTION

Presently, lentils are a $64 million business to Saskatchewan producers. This figure appears to be rising with 95% of lentil production being exported out of Saskatchewan.

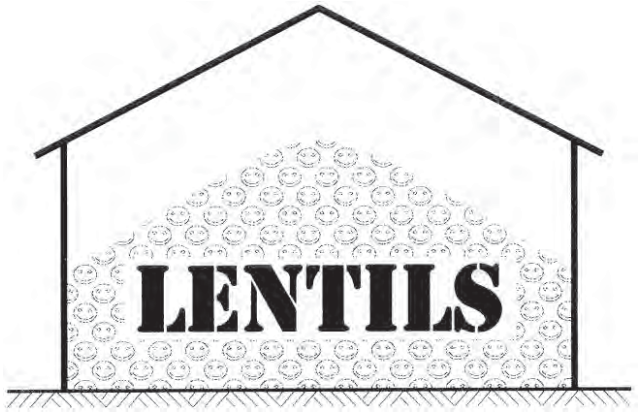
Until now most of the product has been quickly sold, thus requiring very short storage periods. If lentil supply exceeds demand, extended storage periods will become a reality.

Lentil seed coats may darken during storage or shipment. From previous research, this "darkening" has been attributed to the oxidation of tannins in the seed coat[2].

Reduction in lentil quality through colour change will decrease their value. Market value losses of 13 to 45% for Laird lentils, and 31 to 35% for Eston lentils could result, depending on the extent of darkening. These losses, on an annual provincial scale, could exceed $1.6 million.

Previous research has indicated that the most dramatic changes in seed colour occurred in high humidity and high temperature. Also, loss of germination was observed when the lentils turned brown. For producers and seed growers, loss of germination can become costly if the crop was to be used as seed.

In 1991, PAMI initiated a research project on lentil storage. The objectives of this project were: 1) to determine the change in quality of lentils stored both in steel bins and in various controlled lab conditions, and 2) to provide useful guide lines to lentil producers on improving the storage life of lentils. Funding for this project was provided by Saskatchewan Agriculture and Food, through the Agricultural Development Fund. Technical support and services were provided by: the Canadian Grain Commission, Agriculture Canada, and the Manitoba Research Council.



IN BRIEF... THE CONCLUSIONS

- Under present market conditions, minor colour changes in lentils can cost the producer 13% of the value of Laird lentils and 31% of Eston lentils.
- Major browning of the seed coat may cost the producer 45% and 35% of the value of Laird and Eston lentils, respectively.
- Past research has indicated that there are several reasons for lentil colour change.
- High humidity and high temperatures cause rapid changes in colour. Also, these conditions drastically reduce germination.
- Lentils kept in cold dark conditions had very little or no colour change.
- The presence of light causes significant colour change to the lentils. In this study, colour change was observed after only 6 months.

Good Points to Remember

- Producers should attempt to harvest lentils at or near sale storage moisture contents (M.C.).
- Lentils that are harvested at high M.C. should be dried as soon as possible and cooled to within 10°F (5°C) of average ambient (outside) temperatures. Fans should then be shut down and run occasionally for a few days as the ambient temperature goes down to further cool the grain.
- Care must be taken that aerated lentils are not overdried. Overdrying causes weight loss, profit loss, and makes the lentils more susceptible to handling damage.
- To prevent light from affecting lentils, producers should seal all bin holes where light may enter. · Special attention should be given when bin stirrers are used. Stirrers increase the amount of lentils which are exposed to light.
- If only the top layer shows "browning", selective emptying may be tried to separate the different grades. Also, the producer should ask his grain buyer to sample every truck toad to differentiate the grades.
- Depending on the market demand, the producer should sell the product as quickly as possible. Bins that are prone to "brown" should be sold first.
- In summary, dry them, cool them, store them in the dark, and sell them as quickly as possible.

[1]Funding for this research project has been provided by Saskatchewan Department of Agriculture and Food through the Agriculture Development Fund. Support was also given by the Canadian Grain Commission, Agriculture Canada, and the Manitoba Research Council.
[2]Bhatty 1988, Vaillarscourt et al 1986.

HOW THEY WERE TESTED

The Product: The lentils used in this study were the popular Canadian grown Laird and Eston varieties. Due to good harvest conditions, the lentil crop was of “good quality” and measured 13% moisture content.

Eston lentil samples were cleaned with a No. 12 round dockage hand sieve to remove weed seeds. The Laird lentil samples were cleaned with a No. 5-1/2 round dockage sieve to remove small particles while large foreign material was removed by hand.

Bin Sampling: Six samples were systematically taken from typical circular steel storage bins. A total of 12 samples for each variety of lentils were taken with the intent of again sampling, in the same locations, after 6 and 12 month intervals. All of the samples were to be analyzed for changes Vacuum Packed in seed colour and germination.

Controlled Condition Sample: At the same time as the bin sampling, additional large samples of each variety were returned to the lab where they were cleaned and mixed to provide eight 1.1 lb (500 g) samples of each variety. These samples were then stored at various controlled conditions (TABLE 1). At 6 months and 12 months, 0.22 lb (100 g) portions were removed from each sample for colour and germination analysis.

TABLE 1. Controlled Storage Conditions

Sample No.	Condition
1	Sunlight, Room Temperature, Vacuum Pack
2	Sunlight, Room Temperature, Open
3	Dark, Room Temperature, Vacuum Pack
4	Dark, Room Temperature, Open
5	Dark, Room Temperature. N_2 Pack
6	Dark, Cold, Vacuum Pack
7	Dark, Cold, Open
8	Dark. Alternate Warm and Cold, Open

NOTES:
Sunlight - in clear plastic bags placed in southern window
Room Temperature - at 75 ± 4°F (24 ± 2°C)
Cold - a freezer at +8 ± 4°F (-28 ± 2°C)
Vacuum Pack - in clear plastic bags at 1 atmosphere (101.3 kPa) vacuum
Open - in clear plastic bag which was left open
N_2 Pack - at 1 atmosphere (101.3 kPa) vacuum with nitrogen gas injected prior to sealing
Alternate Warm and Cold - alternated between one week of warm and one week of cold temperatures for the entire 12 months

Instrumentation and Tests: An Instrumar Colormet hand held colorimeter was used by the Canadian Grain Commission (Winnipeg). The colorimeter measured the color changes of the lentils by comparing tristimulus L*a*b* colour readings.

The Colormet reads colour by measuring surface reflectance. The L*a*b* system used by the Colormet maps out a colour into a sophisticated three-dimensional graph.

Analysis involves studying the trends of the readings along each of the three L*a*b* axis where:

- L* (dark/light axis) or (black = 0, white = 100) or (decrease L* = darker)
- a* (red/green axis) or (+60 = red, -60 = green) or (increase a* = browner)
- b* (yellow/blue axis) or (+60 = yellow, -60 = blue)

In the case of lentils, we are primarily interested in the a* and L* values. As indicated above, an increased a* value is “browner” while a decreased L* value is “darker”. Lentils which become “browner” or “darker” are considered poorer quality for grading purposes.

Germination analysis was performed by PAMI and by Agriculture Canada.

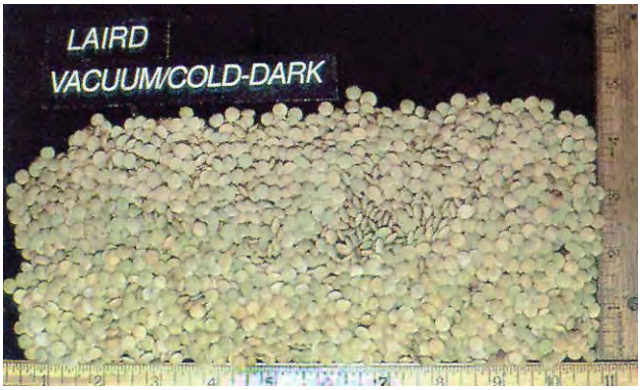


FIGURE 1. Laird Lentils (12 months under Sample Condition No. 6) - Dark, Cold, and Vacuum Packed.

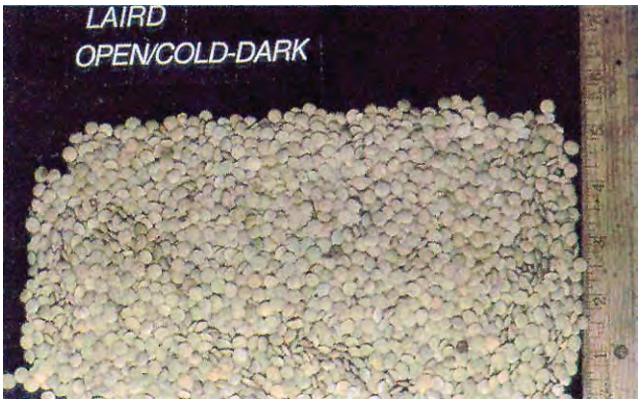


FIGURE 2. Laird Lentils (12 months under Sample Condition No. 7) - Dark, Cold, and Open.

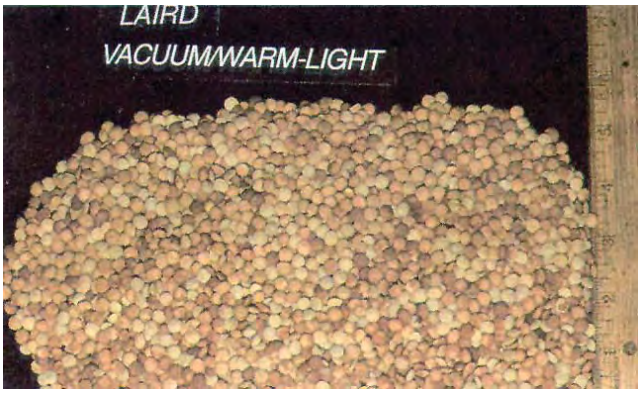


FIGURE 3. Laird Lentils (12 months under Sample Condition No. 1) - Sunlight, Room Temperature, and Vacuum Packed.

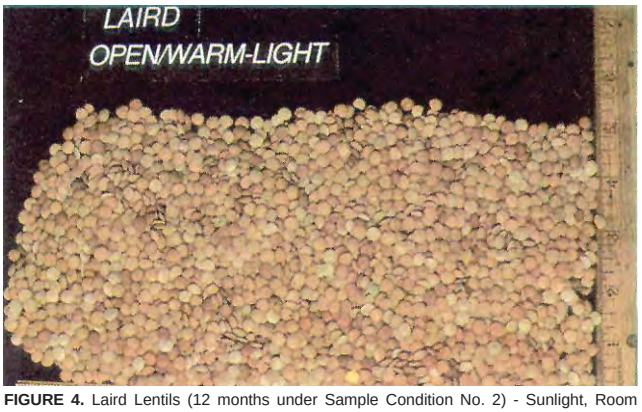


FIGURE 4. Laird Lentils (12 months under Sample Condition No. 2) - Sunlight, Room Temperature, and Open.

FIGURE 5. Eston Lentils (12 month under Sample Condition No. 6) - Dark, Cold, and Vacuum Packed.

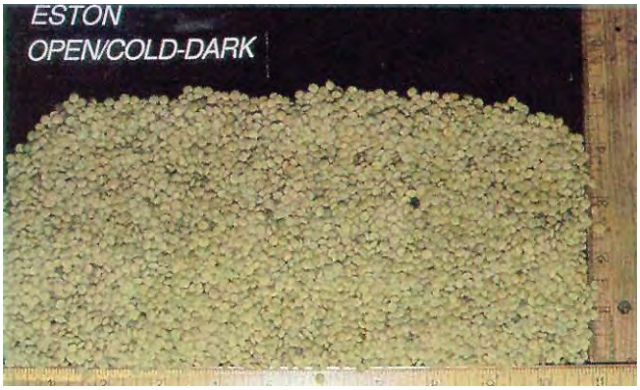


FIGURE 6. Eston Lentils (12 months under Sample Condition No. 7) - Dark, Cold, and Open.

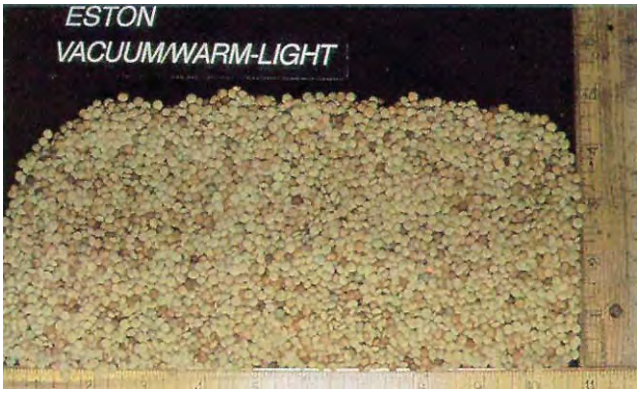


FIGURE 7. Eston Lentils (12 months under Sample Condition No. 1) - Sunlight, Room Temperature, and Vacuum Packed.

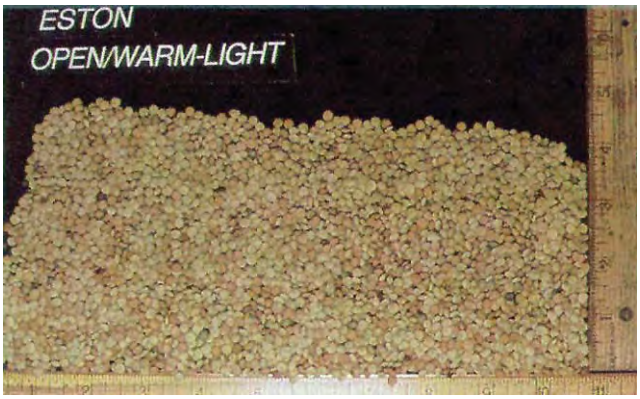


FIGURE 8. Eston Lentils (12 months under Sample Condition No. 2) - Sunlight, Room Temperature, and Open.

WHAT WHERE THE RESULTS

Bin Samples: Good market conditions for lentils, during the winter of 1990/91, resulted in sales for the already sampled product. All the sampled bins were sold within 3 months of harvest.

No visible colour change in the lentils was evident from harvest to the time of sale. Since the storage period was so short, no germination tests were conducted at the time the lentils were sold.

Colour Change: The visual effects of the different treatments on colour are shown in FIGURES 1 to 8. The “cold, dark” treatments maintained their colour much better than the “warm light” samples. Dark and cold appeared to be the two most important criteria to maintain colour. There was little difference between the “open” and “vacuum packed” samples.

The Colormet spectrophotometer L*a*b* readings at harvest, 6 months and t2 months (for each storage condition) are shown (TABLES 2 and 3) for Laird and Eston lentils.

After 12 months, the larger a* (browner) values of “lighted and warm” samples indicated a change to red. Laird lentils had L* (darker) values slightly lower indicating a darkening of the seed coat. Sample #7 (dark-cold-open) had very little a* (brown) change from harvest to 12 months, with a corresponding very small change in colour. This confirms the visual results that “dark and cold” are effective in maintaining colour. This can be achieved by storing in good bins that will seal out the light and using a fan to cool the grain during cool outside conditions.

The samples that used the special treatments of N= packed (#5) and vacuum packed (#6) were about the same as the “open” sample (#7). Thus, these spiral systems would be of no practical benefit.

Literature studies indicate that high humidity and high temperature together cause rapid browning of lentils. Producers who harvest lentils at high moistures should dry them with a drying fan. The fan should be run occasionally for a few days into the winter to cool the grain down as outside temperatures drop.

TABLE 2. Spectrophotometer Readings for Laird Lentils

Sample No. (See Table #1)	Harvest			6 Months			12 Months		
	L*	a*	b*	L*	a*	b*	L*	a*	b*
1	57.0	3.7	25.7	54.7	6.4	22.5	47.5	13.3	22.8
2	57.0	3.7	25.7	53.0	8.1	23.3	48.9	12.7	23.8
3	57.0	3.7	25.7	55.5	4.5	24.0	54.5	5.3	24.1
4	57.0	3.7	25.7	55.1	5.1	23.8	54.1	6.0	23.0
5	57.0	3.7	25.7	55.0	3.6	22.5	56.1	5.2	24.8
6	57.0	3.7	25.7	56.6	3.6	24.2	55.5	4.4	24.0
7	57.0	3.7	25.7	56.1	4.3	24.4	56.9	3.7	24.3
8	57.0	3.7	25.7	56.3	5.8	23.8	55.5	5.6	23.5

L* (decrease = darker)
a* (increase = browner)

TABLE 3. Spectrophotometer Readings for Eston Lentils

Sample No. (See Table #1)	Harvest			6 Months			12 Months		
	L*	a*	b*	L*	a*	b*	L*	a*	b*
1	54.8	2.8	24.2	57.1	2.3	25.3	54.8	6.0	23.5
2	54.8	2.8	24.2	55.6	3.8	23.0	55.0	5.4	23.4
3	54.8	2.8	24.2	55.5	4.5	24.0	56.1	3.8	25.7
4	54.8	2.8	24.2	55.1	5.1	23.8	55.3	4.0	25.1
5	54.8	2.8	24.2	58.1	1.2	25.1	57.3	2.5	25.1
6	54.8	2.8	24.2	57.4	1.8	25.5	57.0	2.0	24.8
7	54.8	2.8	24.2	56.1	4.3	24.4	56.8	1.7	24.6
8	54.8	2.8	24.2	55.7	2.5	24.0	56.0	3.3	24.8

L* (decrease = darker)
a* (increase = browner)

Germination: TABLES 4 and 5 show the germination results for the Laird and Eston lentils. The results are recorded at harvest, 6 month and 12 month periods.

The Eston samples contained a large number of hard seeds at harvest time. These hard seeds produced low germination at harvest, however, few hard seeds remained after 6 months and 12 months of storage. The Laird samples did not contain any hard seeds.

In this study, the sample exposed to fluctuating temperatures had lower germination rates than in other storage conditions. This

unexplainable result contradicts previous research. “Fluctuating temperatures for germinating seeds are generally beneficial and result in increased germination”, (Merva 1975).

The nitrogen packed samples showed no overall trend for germination change. Pumping nitrogen into a bin would not be a cost effective method of preventing germination loss.

FURTHER INFORMATION

For further information, contact PAMI at 1-800-567-PAMI and ask for Report #RH0490, “Improved Storage Life of Lentils” (Cost: $5.00).

To discuss specific results, contact the authors: Doug May, Project Engineer, or Ken Maloff, Information Services, at the above telephone number.

TABLE 4. Germination (%) for Laird Lentils Under Various Storage Conditions

Sample No. (See Table 1)	Germination (%)		
	Harvest	6 Months	12 Months
1	93.4	93.0	90.0
2	93.4	91.0	92.0
3	93.4	90.0	86.0
4	93.4	87.0	90.0
5	93.4	86.0	86.0
6	93.4	88.0	92.0
7	93.4	87.0	92.0
8	93.4	84.0	85.0

TABLE 5. Germination (%) for Eston Lentils Under Various Storage Conditions

Sample No. (See Table 1)	Germination (%)		
	Harvest	6 Months	12 Months
1	85.4	99.0	98.0
2	85.4	99.0	98.0
3	85.4	100.0	99.0
4	85.4	98.0	97.0
5	85.4	99.0	99.0
6	85.4	94.0	99.0
7	85.4	96.0	99.0
8	85.4	94.0	96.0

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