

BIBLIOGRAPHY

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ABSTRACT

Collection and monitoring of two lettuce farmers on postharvest diseases of variety Romaine was done at the Cold Storage Facility Wangal, La Trinidad, Benguet. It was found that only soft rot was identified as the postharvest disease; symptoms was observed as; soft watery soaked lesions that starts at the fleshy portion of the produce accompanied by a foul odor and was caused by a *Pectobacterium carotovorum* that is rod shape and gram negative.

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INTRODUCTION

Background of Study

Lettuce (*Lactuca sativa L.*) is one of the very oldest vegetables cultivated by man. It is known as a popular major salad crop (Snowdon, 1992). Lettuce is rich in mineral nutrients such as calcium, iron, and magnesium, also rich in vitamins like vitamin A, thianin and niacin (Anonymous, 2001).

Lettuce varieties can be loosely categorized into four groups: the Crisphead, Butterhead, Leaf and Romaine or Cos. Crisphead lettuce is probably the most familiar of the four. A tight, firm crisp head, light green leaves, which characterizes it. It is generally intolerant of hot weather and will readily bolt or send up a flower stalk under that summer conditions. Its long growing period also makes it one of the most difficult among the lettuce varieties to grow. The butter head types have a smaller, softer heads of loosely folded leaves. The outer leaves may be green or brownish with cream or butter colored inner leaves. Leaf lettuce has an open growth and does not form a head. Color ranges from light green to red and bronze, this matures quickly and the easiest to grow. Romaine or Cos lettuce forms an upright cylindrical heads of tightly folded leaves. It may reach up to 10 inches in height. Of the four types Romaine is said to be the sweetest (Knott and Deanon, 1967).

All lettuce types should be harvested when they have reached full size but are still young and tender. Over mature lettuce is bitter and woody. Leaf lettuce is harvested by removing individual outer leaves, leaving the center leaves to continue to grow. Butter head and Romaine types can be harvested by removing the leaves, digging up the whole



plant or cutting the plant about an inch above the soil surface, usually allowing for a second harvest. While the crisp head is picked when the center is firm (Wolford, 2006).

Some postharvest diseases of lettuce are white rot, which is also known as “lettuce drop” in the field, pink rib which causes a diffused area at the midrib base, bacterial soft rot which is characterized by a wet, slimy decay with extensive brownish discoloration, and russet spotting which appears on the lower midribs of the outer leaves (Anonymous, 2003a).

Lettuce is known as highly perishable crop producing shallow roots. Due to improper postharvest practices such as handling and improper storage, lettuce is easily damaged and is prone to diseases and deterioration thereby affecting its quality and quantity. It is the aim of most lettuce growers to increase their yield to supply the needs of consumers and to meet their domestic demands (Ryder, 1999).

Proper postharvest storage is vital in lettuce production. An ideal condition for storage is at 1°C (34°F). With daily transport of the product to market, the lettuce may remain in the cooler for less than one day, but should be cooled for at least 12 hours to remove the heat from the crop. For highest quality, the lettuce should not be stored more than 7 days in coolers (Wolford, 2006).

Cold Storage Facility was established in the province through the Department of Agriculture and the Bureau of Postharvest Research and Extension. It is very important to farmers because prices of vegetables are not always high. Hence, so farmers tend to store their commodity at the cold storage while waiting for the price to increase.



The study aimed to monitor the postharvest diseases of lettuce at the cold storage facility at Wangal, La Trinidad, Benguet to provide assistance to local farmers to improve their production, generate income and to minimize postharvest losses.

The study was conducted at the Cold Storage Facility Wangal La Trinidad Benguet from November to December 2007 to February 2008.



REVIEW OF LITERATURE

The Crop

Lettuce (*Lactuca sativa L.*) belongs to Asteraceae (compositae) family. In plant kingdom it is the largest dicotyledonous family. This is an annual herb with milky latex in the leaves and stems, which prefers a slightly acidic pH from 6.0 to 6.5-soil condition (Ryder, 1999).

Lettuce does not need a lot of water but it does need to be continuously moistened. Growing lettuce in a semi-shaded to shaded location and using straw mulch around the plants will help retain moisture. A wand is used in watering to concentrate the application of water at the base of the plant, not on the leaves. Watering the leaves encourages diseases and may damage some varieties of the more delicate lettuces (Kerns and Palumbo, 1996).

Several disorders occur on Romaine lettuce. Some very common disorders are the following:

Physiological Disorders

Tip burn is a disorder caused in the field and is related to climatic conditions, variety selection and mineral nutrition. Leaves with tip burn are unsightly as it damages the leaf margin which makes it susceptible to decay (Cantwell and Suslow, 2005). Ethylene injury is due to exposure to low concentrations of ethylene gas that stimulates the production of phenolic compounds, which in turn leads to brown pigments. Russet spots appear as dark brown spots especially on the midribs. The disorder is strictly cosmetic but makes the lettuce unmarketable. Symptoms of this disorder in Romaine lettuce heads are yellowish-reddish-brown large, depressed spots or stains. These are



most noticeable on the midribs, and may darken and enlarge with time. Brown stain is caused by exposure to carbon dioxide especially at concentration of above 5%. It also includes the pink rib disorders associated with heads that are over mature. Higher than recommended storage temperatures can also lead to an increased incidence of pink rib with the midribs which have a pinkish coloration (Njue, 2007).

Pathological Disorders

The pathological disorders are the bacterial soft rots which are caused by numerous bacteria species and result in a slimy breakdown of the infected tissue. Trimming outer leaves, rapid cooling and low temperature storage will reduce development of bacterial soft-rots. And the fungal pathogens may also lead to a watery breakdown of lettuce (watery soft-rot caused by *Sclerotinia* or gray mold rot caused by *Botrytis cineria*) but are distinguished from bacterial soft rots by the development of black and gray spores(Njue, 2007).

Postharvest Handling and Vegetable Quality

Harvesting vegetables should begin at the proper stage, size and quality. Crops destined for storage should be as free as possible from skin breaks, bruises, spots, rots, decay and other deterioration. Bruises and mechanical damage not only affected appearance, they also provide an avenue for the entry of pathogens. To prevent damage, handle gently and field pack if possible. Besides handling, temperature is another factor important in maintaining harvest quality. Sanitation is of great concern to protect the



produce against postharvest diseases, but also to protect consumers from associated food-borne illnesses (Njue, 2007).

The use of hydrocooling can be done. Hydrocooling is the process of spraying or immersing vegetable in chilled water. However, before subjecting the lettuce to this process, the lettuce must be cleaned. Lettuce is very sensitive to ethylene gas so lettuce should not be stored with vegetables and fruits that give off ethylene gas (Kerns and Palumbo, 1996).



MATERIALS AND METHODS

Monitoring of the lettuce samples

This was done by observing the Romaine lettuce heads samples at the Cold Storage facility and rated accordingly. Assessment was done using the parameters such as disease incidence, disease severity and quality. Observation was done every 24 hours

Description of Symptoms

A detailed description of symptoms was used. Sample of the diseased specimen were brought to the Plant Pathology Laboratory for further diagnosis and proper documentation.

Morphological Characterization of the Pathogen

Preparation of semi-permanent mounts was done and observed in the microscope to determine and characterized the pathogen involved. Isolation was also done to determine if the causal organism that was observed in the semi-permanent mounts are similar with the pure culture.

Documentation

Lettuce samples were done for both the symptomatology and the morphological characterization of the causal agents.

A pure culture of the pathogen was done following the entire method of bacterial diseases which was the streak method on Nutrient Agar (NA).



Data gathered

1. Percent disease incidence

$$\% \text{ Disease incidence} = \frac{\text{Total number of samples} - \text{no. of diseased samples}}{\text{Total number of samples}} \times 100$$

2. Percent disease severity (based on host surface infected) using the rating scale indicated (Ilag, 1987).

Rating Scale:

<u>Scale</u>	<u>Description</u>
1	No infection
2	1-5% of the commodity surface infected
3	6-10% of the commodity surface infected
4	11-25% of the commodity surface infected
5	26-50% of the commodity surface infected
6	Over 50% of the commodity surface infected



RESULTS AND DISCUSSION

Identified Postharvest Disease

Soft rot (*Pectobacterium carotovorum*)

Symptom. Soft rot lettuce is characterized as a watery decay coming out from the infected plant part, with foul odor. As cited by Aliado, 2006 bacterial soft rot of lettuce is characterized by the appearance of water-soaked lesion at the butt-end of the commodity (Figure 3).



Fig. 3. Infected with soft rot



Fig. 4. Healthy Romaine

Morphological Characteristic of *P.carotovorum*. Microscopic examination of the infected tissue from advancing lesion showed the presence of bacterial ooze and it was further examined using the gram staining method. Result of the gram stain revealed that the bacterium is gram negative and rod shape, similarly with the result of Aliado, 2006



that the causal bacterium of soft rot of lettuce Iceberg variety is gram negative and rod shape (Fig.6).

Cultural Characteristic. The pure culture after two days (48 hours) produced a light yellow colony in Nutrient Agar (NA) (Fig. 5). The result further confirms the study of Alaido, that *P.carotovurum* produced a creamy white colony with margins that is entire and smooth surface. Elevation is convex and its form is circular.



Importance of the Cold Storage Facility

The cold chain process of handling of harvested vegetables reduces postharvest losses and extends the freshness and quality of high value crops. It helps farmers meet the demand of the market for a year round supply of fresh quality of vegetables and fruits.

There are different components of the cold chain facilities for high value crops which are packing houses, pre-coolers, cold storage rooms, refrigerated trucks, refrigerated stalls and chillers in the supermarket and restaurants. After harvest, the lettuces are brought to the packing house, an area for the trimming, cleaning, sorting, and grading of the farm produce. From the packing house, the harvested vegetables are brought to the pre-cooler which immediately remove the field heat from newly harvested crops. Then to the cold storage to maintain the required temperature and humidity and allows the perishable crops to be stored for a longer period with a temperature of 2°C. Refrigerated vans and trucks are used to transport the vegetables from the field to the cold storage (Fig. 1).

Postharvest Practices of the farmer Cooperators

Harvested lettuces are packed in layers with the plastic crates with 17 to 20 heads in a lying position. In the case of Mrs. Ching she transports the lettuce in plastic crates using the refrigerated van, while Mr. Santos uses an elf to transport his harvest from the field to the cold storage facility. The lettuces are stored at the cold storage facility for one to two days before they are delivered to the market (Fig. 2).





Figure 1. Romaine lettuce in a refrigerated van



Figure 2. Cold Storage Facility at Wangal La Trinidad Benguet





Figure 5. Pure Culture of the bacterial isolate on Nutrient Agar (NA) (48 hours)

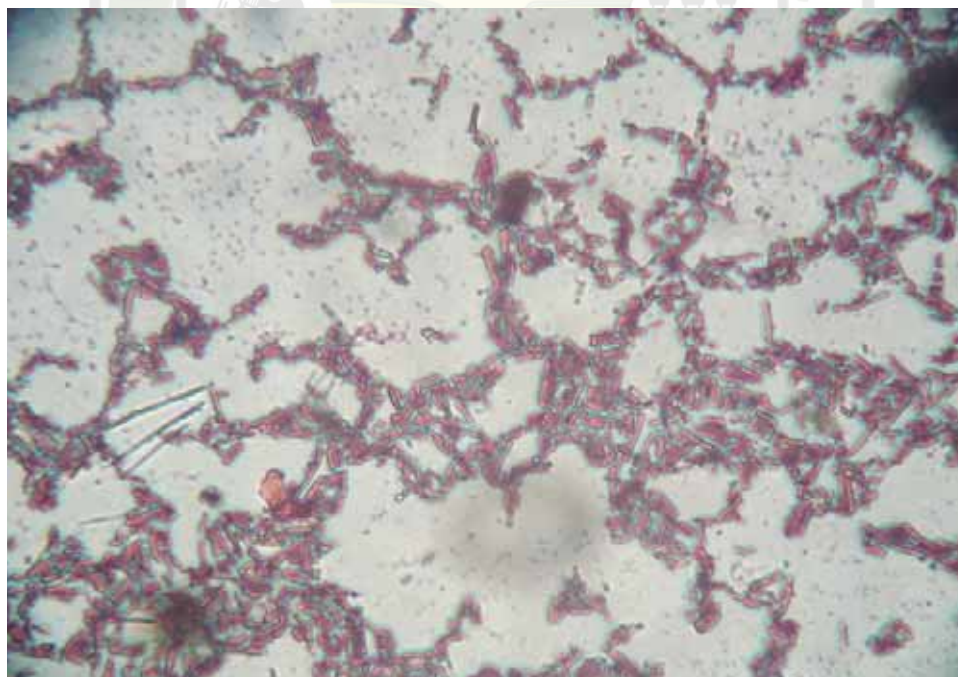


Figure 6. Stained bacterial isolate (1000x)

Table 1. Percent (%) disease incidence

SAMPLES	TOTAL NUMBER OF SAMPLES	NUMBER OF DISEASED SAMPLES	PERCENT (%) INFECTION
Mr. Santos	17	17	100
Mrs. Ching	17	15	88.24

From the samples observed with the two farmers, Mrs. Ching had the less number of diseased samples. The high incidence of soft rot maybe due to the presence of the bacterium in the plant sample prior to storage. In addition, since lettuces are packed in crates with out liner, infection may have spread from infected to healthy lettuce.

Table 2. Percent (%) disease severity

SOFT ROT SEVERITY OBTAINED FROM TWO FARMERS ONLY AFTER 24 HOURS OF OBSERVATION		
No. of samples	Mrs. Ching	Mr. Santos
1	1	2
2	2	3
3	2	3
4	2	2
5	2	3
6	1	3
7	3	2
8	2	2
9	2	3



Table 2. Continued...

SOFT ROT SEVERITY OBTAINED FROM TWO FARMERS ONLY AFTER 24		
HOURS OF OBSERVATION		
No. of samples	Mrs. Ching	Mr. Santos
10	2	2
11	2	3
12	3	2
13	2	3
14	2	2
15	2	3
16	2	3
17	2	3

% Disease Severity (based on host surface infected) using the rating scale (Ilag, 1987).

Rating Scale:

<u>Scale</u>	<u>Description</u>
1	no infection
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5	26-50% of the commodity surface infected
6	over 50% of the commodity surface infected



The 88% and 100% soft rot infection observed from lettuce obtained from Mr. Santos and Mrs. Ching can be due to the soft rot *P. caratovorum*.



SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

Collection of postharvest diseased Romaine lettuce heads was done at Wangal Cold Storage Facility, La Trinidad, Benguet from two farmers. Diseased Romaine lettuce heads were placed or incubated in clean plastic bags for further diagnosis of postharvest diseases. Morphological characterization and isolation of the pathogen was done at the Department of Plant Pathology following the pathogenicity test for plant pathogens (Koch's postulate). Bacterial pathogen associated with Romaine lettuce heads was identified through symptomatology, morphological and cultural characters of the pathogen.

Conclusion

The postharvest disease of Romaine lettuce at the Cold Storage Facility was identified as soft rot of vegetable caused by *Pectobacterium carotovorum*.

Recommendations

1. A follow-up studies must be done to identify other postharvest diseases of lettuce.
2. Prior to storage, vegetables must be properly cleaned or trimmed-off of diseased portion should be done.
3. Farmers using the facility should follow postharvest and storage practices like the trimming (removal of outer leaves), only healthy and uninfected commodity should be stored. When packing leafy vegetables in plastic crates, liners be placed at the butt end



of the commodity and should be stored in an upright position to lessen the spread of soft rot infection.

4. Proper sanitation should be observed like the disinfection of the plastic crates with 10% chlorox before use.



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