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## Quality assessment of blueberries by computer vision

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### Abstract

Blueberry's main quality indicators associated to consumer acceptability are related to the fruit appearance and texture. To date, appearance quality assessment is determined subjectively using visual observation. Computer vision analysis is an useful tool to evaluate fruit optical properties. The objective of this work was to study quality indicators for different blueberry cultivars hand-harvested in Chile during storage using computer vision. Five cultivars were analyzed: *Brigitte*, *Duke*, *Elliot*, *Centurion* and *Star*; 50 individual fruit from these cultivars were stored at 4°C and 15°C during 21 days at 90% of relative humidity. Quality indicators: colour, presence of epicuticular wax (EW), size, dehydration and microbial growth were determined through image analysis obtained by computer vision. Different values of each quality attribute were obtained between cultivars. Dehydration values (measured as sample size changes during storage) at 15°C were 2.7 and 39.6% for *Brigitte* and *Centurion*, respectively. EW presence for all was lower of 33% of the surface, which is the minimum for export, except to cv. *Brigitte* (75%), which was associated to low dehydration. Colour measured with CIEL\*a\*b\* scale showed changes from blue to red for all cultivars at both temperatures during storage. Fungal presence increased at higher temperatures, which was represented by an increased lightness. The implication of this work is that computer vision analysis is useful to objective quality evaluation of fruits such as colour, dehydration signs and fungal growth - most important attributes for consumers- and epicuticular wax presence, which is important to protect against deteriorative changes during storage, allowing heterogeneous materials analysis and their possible application in on-line packing control.

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*Keywords:* computer vision; blueberries; quality assessment; epicuticular wax; colour

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## 1. Introduction

Worldwide consumption of blueberry has increase significantly over the years because its health benefits. Blueberries are blue little fruits from *Vaccinium* genus with high nutritional value and potential anti-disease effects but with a short shelf life. Blueberry main quality indicators are related to the fruit appearance (colour, epicuticular wax presence, size and shape) and texture. Therefore, changes in parameters of appearance have a profound effect on consumer acceptability. Despite the importance of the assessment of this parameters up to date, appearance quality are determined subjectively using visual observation.

Computer vision (CV) analysis is an useful tool to evaluate fruit optical properties for heterogeneous materials. CV is a non-destructive technology for acquiring and analyzing a digital image to obtain information of the product or to control processes [1] and it has been regarded as a valuable tool to improve the automatic evaluation of food quality [6, 7]. CV has been used in the food industry for quality and colour evaluation, detection of defects, grading and sorting of fruits and vegetables, meat and fish, bakery products and potato chips, among other applications [2-4, 6-7].

The objective of this work was to study quality indicators associated to consumer acceptability, necessary for export of different blueberry cultivars hand-harvest in Chile during storage using computer vision.

## 2. Materials & Methods

### 2.1. Blueberry cultivars and storage conditions.

Blueberry cultivars (*Brigitte*, *Duke*, *Elliot*, *Centurion* and *Star*) were acquired from a local producer from Curacaví near Santiago of Chile (Hortifrut S.A.), kindly donated by Blueberry Committee of Chilean Association of Exporters. Blueberries were manually picked at full maturity (100% blue) and transported to the laboratory on the same day. High quality blueberries were sorted by hand; discarding excessively small, soft, visually damaged and those without presence of pedicel and flower rest for all experiments (n=25 in duplicate). The fruits were stored during 21 days at constant temperature of 4 and 15°C and relative humidity (RH) of 90%.

### 2.2. Image Analysis using Computer Vision

Digital images from each blueberry (both front and back) were captured at each storage time through a computer vision system, which consisted of a black box with four natural daylight (D65) tubes of 18W (Phillips) and a camera (Canon 4 MP Powershot G3, Japan) placed in vertical position at 22.5 cm from samples (the camera lens angle and light was 45°, according to Pedreschi et al. (2006)). All images were remotely acquired using same conditions by ZoomBrowser software (v6.0 Canon).

Colour data was measured in the CIEL\*a\*b\* space using Matlab software. The presence of epicuticular wax (EW) was analyzed using Photoshop software. Dehydration signs and presence of fungal filaments were determined visually through image analysis obtained by computer vision.

## 3. Results & Discussion

Dehydration values (measured as sample size and visual changes) were 2.7 and 39.6% for cv. *Brigitte* and *Centurion*, respectively after 21 days of storage at 15°C. Equatorial diameter for each studied cultivar is showed in Figure 1, indicating that cv. *Centurion* was also the smallest fruit.

Dehydration signs and equatorial size are important quality blueberry variable for international rules of exportation.

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