WASHING WATER TURBIDITY AS INDICATOR TO FRUIT AND VEGETABLE WASHER EFFICIENCY

H.S. Al-Katary
H.A. Abd El-Mawla
M.A. Osman
and A.M. Ahmed

ABSTRACT

The main goal of the present investigation was to study of using washing water turbidity to measure transparency of the water as a parameter that indicate vegetable and fruit washing efficiency. Turbidity can measure by turbidity measuring device to improve the quality of the process with low complexity. Laboratory tests of the operation have yielded satisfactory repeatability and stability. Washing productivity of the washing machine, washing efficiency of the washing machine, Analysis of Water (turbidity) and fruit damage percentage were resulted.

Keywords: turbidity, washable, quality.

INTRODUCTION

Harvested crops usually contain some of unwanted material such as leaves, twigs, stems, soil, and residues of pesticides. Removal of these unwanted materials as early as possible after harvest is important in order to avoid: crop contamination from bacteria, fungi, soil, and residues of pesticides, damage to the crop (like stick punctures in fruit). Additional heats build up in the crop from respiration of unwanted material, improve product appearance and edibility, Remove residues of field-applied and harmful chemicals, Microorganisms those would shorten the life of the product. Abd El Rahman (1999).

Many crops must be cleaned after they are harvested to improve product appearance and edibility to remove residues of field-applied chemicals and to remove harmful microorganisms that would shorten the life of the product. Hassan (1988) and Hossain et al., (1991). Papadopoulou et al., (1998) mention that the clarity of the water which

---

2 Prof. and Head of Agric. Eng. Dept., Fac. of Agric., Al-Azhar Univ., Assiut.
3 Prof. of Food Sci. and Tech., Dept., Al-Azhar Univ., Nasr city.
is affected by the concentration of suspended particles is a measure of its quality. Drinking water should have a turbidity of ≤ 5 NTU Davis et al., (2002). The WHO (2004), (World Health Organization), established the turbidity of drinking water should not be more than 5 NTU (Nephelometric Turbidity Units), and should ideally be below 1 NTU. Turbidity is an expression of the optical property of a medium, which causes light to be scattered and absorbed rather than transmitted straight through a sample. The medium concerned is usually water in which light is scattered by suspended particles. Turbidity is defined by the International Standards Organization (ISO) as the “reduction of transparency of a liquid caused by the presence of undissolved matter”. It is measured using the techniques of turbidimetry or nephelometry and is expressed in arbitrary units NTU (Nephelometric Turbidity Units). The direct relationship between turbidity data and suspended solids concentration depends on many factors, including particle size distribution, particle shape and surface condition, refractive index of the scattering particles and of the suspension medium and wavelength of the light. Lawler (1995).

The washing efficiency was calculated by Scott et al., (1981).

\[
WE = \left( \frac{SR}{SA} \right) \times 100, \%
\]

Where: \(WE\) = Washing efficiency, \%.

\(SR\) = Mass of foreign materials removed by washing = Mass of sample before washing - mass of sample after washing, g/kg.

\(SA\) = Mass of foreign material attached, which was estimated by, hand washing of 30 samples of fruits to full cleaning and weighing the foreign materials attached with one kg of fruits (g/kg).

The aim of this study is to using a turbidity for indicate quality of some vegetables and fruits that be washed in the washing machine.

**MATERIAL AND METHODES**

**Material:**

1. **Tested vegetable and fruit:**
The tested-fruits types were Navel orange and Nicola potatoes.

2. **Designed washing machine.**
The designed washing-machine consists of the following parts
2.1. **Frame.**
The frame consists of 1 Inch (2.54 cm) iron angles with 200 cm length, 50 cm width and 100 cm height.

2.2. **Fruit hopper.**
The hopper was made of galvanized-steal sheet. With 70 cm length, 90 cm width in top, and 20 cm length and 30 cm in bottom. The hopper height is 50 cm. The capacity of fruit hopper is about 92.5 kg orange fruits and about 77 kg potatoes. Fruit hopper was designed according to mechanical and physical proprieties of fruits fig. 1.

The brush was made of 4-inch PVC pipe. With 150 cm length, the brush consists of plastic wisps with about 100 hairs. The wisps are fixed on 4 inches PVC pipe by about 2.5 cm plastic tubes which interfered with PVC pipe by about 3 cm screw bolt. The wisps fixed around PVC pipe have auger shape.

2.4. **Electrical motor.**
The specifications of electrical motor are 0.4 kW power, 1400 rpm.

2.5. **Power transmission.**
Power transmission consists of gearbox, pulleys and V belt. Motored pulleys of 4 cm diameter transmits the power to 15, 11.2 or 9 cm diameter, gear box pulleys to give speeds of 357, 500, 625 or rpm. The gearbox reduction ratio is 1/12.5 to give pipe brush speed 30, 40 or 50 rpm.

2.6. **Washing basin.**
The washing basin was made of galvanized sheet steel with 150 cm length, 50 cm width and 25 cm depth with three sides 20 cm length × 150 cm long.

2.7. **Drainage water basin.**
Drainage water basin also made of galvanized steel sheet with 150 cm length and 50 cm width fabricated as a half of circle with 25 cm of radius and capacity about 0.147 m³ (∼145 liter) of water.

2.8. **Sponge drying sheet.**
The drying sheet was made of sponge sheet with 50 cm width and 50 cm length.
Plat 1: Elevation feature of the washing machine.

Fig. 1: Schematic diagram of washing machine.

2.3. Washing brush.
2.9. Filter.
The Filter was made of cylindrical of fiberglass with 15 cm diameter, 30 cm height and 10 bars maximum pressure.

2.10. Pump.
A centrifugal pump of 1.5 hp (1.1 kW), 1ph, and 230 V. was used.

3. Instruments:
3.1. Electronic balances.
An electronic Korean balance model THP-600 TAYO Company with accuracy is 0.01 g and maximum scale of 600 g was used to measure fruits sample mass.

3.3. Turbidity measuring device.
The Turbidity measuring device Japan Model. HORIBA with High sensitive turbidity sensor ranged between 0 and 1,000 NTUs (Nephelometric Turbidity Units) was used to check water quality.

3.5. Stop watch and caliper.
Stopwatch and caliper were used to record the time spend in washing operation and masseur different dimensions.

Operation theory of designed washing machine.
The system of washing represented in the product brushed and displaced by the moving brush until arriving to dryer sheet. The discharged out, so the foreign materials are removed from the surface of the product or dissolving in discharged water.
The water discharged after washing through the filter that removes the suspended materials from the water. The cleaned water pumped to the washing machine outlets.

Methods:
1. Productivity of the washing machine.
The washing Productivity was calculated according to Amin (1995) by the following equation:

\[ C = M \times 60/T_w \], ----------------------------------------------- (3).

Where:
\( C \) = Washing capacity of the machine (Ton / h).
\( M \) = Mass of the washed fruit, (Ton).
\( T_w \) = Washing time, (min).
2. Efficiency of the washing machine by using Turbidity measuring device.

\[ \text{WE} = \left( \frac{T}{t} \right) \times 100, \% \]  

Where:

\( T \) = Turbidity ratio in water after washing by machine, NTU for 1 Kg fruit/1 liter pure water

\( t \) = Turbidity ratio in water after washing by hand, NTU for 1 Kg fruit/1 liter pure water.

3. Analysis of turbidity.

After completion of washing process samples of the dirty water was collected from the 1 liter per 1 kg vegetables or fruits that washed by machine and comber it with sample of 1 liter per 1 kg vegetables or fruits that washed by hand.

4. Fruit damage percentage.

To determine the surface injuries in fruits, the sample was taken and deluged in a staining solution (2% Gentian violet) for five minutes, the surface injures reading will be visible.

In table 1 Mechanical injury can be classified according to Kader (1992) into the following categories.

Table 1: Categories of fruits mechanical injury (Kader, 1992.)

<table>
<thead>
<tr>
<th>No.</th>
<th>Injury Categories</th>
<th>No. of fruits injured, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No symptoms</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Slight</td>
<td>&lt; 2</td>
</tr>
<tr>
<td>3</td>
<td>Moderate</td>
<td>2 - 5</td>
</tr>
<tr>
<td>4</td>
<td>Severe</td>
<td>5 - 10</td>
</tr>
<tr>
<td>5</td>
<td>Extreme</td>
<td>&gt; 10</td>
</tr>
</tbody>
</table>

RESULTS AND DESCUSSION

The operating tests of the turbidity measuring device on the washable product quality indicated that:

1. Productivity of the washing machine.

The productivity of the washing machine was calculated. It can be noticed that 1.35 ton / h was the best productivity with 10 kg / min feeding rate, 15° washing basin and 40 rpm. Brush speeds to the Navel orange.
Moreover, 1.24 ton / h was the best productivity in the lowest standard error with 10 kg / min feeding rate, 15° washing basin and 50 rpm. brush speeds to the Nicola potatoes. As shown in Fig. 2 to Navel orange and Fig. 3 to Nicola potatoes.

2. Washing efficiency of the washing machine.
The Washing efficiency of the washing machine was calculated. It can be noticed that 90 % was the best efficiency with 5 kg/min feeding rate, 10 degree washing basin and 40 rpm. brush speeds to Navel orange. In addition, 92.4 % was the best efficiency in the lowest standard error with 10 kg/min feeding rate, 5 degree washing basin and 30 rpm. brush speeds to Nicola potatoes. As shown in Fig. 4 to Navel orange and Fig. 5 to Nicola potatoes.

3. Analysis of turbidity.
The results of the water turbidity were presented in fig. 6 of 1 Kg fruit/ 1 liter pure water = 224 NTUs to Navel orange. Moreover, the results of the water turbidity were presented in fig. 7 of 1 Kg fruit/ 1 liter pure water = 731 NTUs to Nicola potatoes.

4. Fruit damage percentage.
The best parameters to get the lowest fruit damage percentage of the washing machine affected by the feeding rate of the fruits, angles of washing basin, and speeds of brush. It can be noticed that 0.05 % was the lowest fruit damage percentage (Slight) with 5 kg/min feeding rate, 15 degree washing basin and 50 rpm. brush speeds to Navel orange. In addition, 0 % was the lowest fruit damage percentage (No symptoms) with 5 kg/min feeding rate, 15 degree washing basin and 40 rpm. brush speeds to Nicola potatoes. As shown in Fig. 8 to Navel orange and Fig. 9 to Nicola potatoes.
Fig. 2: Effect of brush speeds on washing productivity of Navel orange at different feeding rates and different angles.

Fig. 3: Effect of brush speeds on washing productivity of Nicola potatoes at different feeding rates and different angles.
Fig. 4: Effect of brush speeds on washing Efficiency of Navel orange at different feeding rates and different angles.

Fig. 5: Effect of brush speeds on washing Efficiency of Nicola potatoes at different feeding rates and different angles.
Fig. 6: Effect of brush speeds on water turbidity of Navel orange at different feeding rates and different angles.

Fig. 7: Effect of brush speeds on water turbidity of Nicola potatoes at different feeding rates and different angles.
Fig. 8: Effect of brush speeds on Fruit damage of Navel orange at different feeding rates and different angles.

Fig. 9: Effect of brush speeds on Fruit damage of Nicola potatoes at different feeding rates and different angles.
CONCLUSIONS
The obtained results of this study could be concluded that ability to using a turbidity as indicate quality of some vegetables and fruits that be washed in the washing machine.

REFERENCES


Hussein, A.; A. Karam, M. Bahgat. 1991. Trading technology of horticultural crops after harvest, the Conference of Post-harvest handling of agricultural, Cairo from 16th - 21st of December, A.R.E.


The Arabic summary


 Abstract

Water hardness as a measure of washing machine efficiency for horticultural fruits and vegetables

Husni Sultan al-Qateri

The aim of this study was to evaluate water hardness as an indicator of the efficiency of washing machines for horticultural fruits and vegetables by comparing the hardness of water samples after washing with that of water samples after manual washing. The study was carried out with two types of fruits: orange 'Abu Serha' (fruit) and potato chips and vegetables (vegetable) in the washing process.

1. Washing machine theory and design:

The washing machine is a machine used to wash fruits and vegetables by rinsing them in water and then collecting them in a drying area. The water used is filtered through a filter to remove any debris, and then recycled through another filter. The results of the study are as follows:

1. Washing machine productivity:

Optimal productivity was achieved when the feeding rate was 5 kg per minute, the washing angle was 15°, and the washing speed was 40 revolutions per minute. For oranges, the productivity was 1.35 kg per hour, while for potato chips the productivity was 1.24 kg per hour.

2. Washing machine efficiency:

Optimal efficiency was achieved when the feeding rate was 5 kg per minute, the washing angle was 15°, and the washing speed was 40 revolutions per minute. For oranges, the efficiency was 90%, while for potato chips the efficiency was 70%.

References:

1. Assistant for Agricultural Engineering, College of Agriculture, Al-Azhar University.
2. Assistant and Head of the Agricultural Engineering Department, College of Agriculture, Al-Azhar University - Assiut.
3. Assistant in the field of food science and technology, College of Agriculture, Al-Azhar University.
4. Instructor in the field of agricultural engineering, College of Agriculture, Al-Azhar University - Assiut.
كفاءة للغسيل عند معدل التغذية 5 كج/ دقيقة، و زاوية حوض الغسيل 10 درجة و سرعة فرشاة الغسيل 30 درجة في وذلك بالنسبة إلى البطاطس نيفولا كانت 92.4٪.

3- نسبة التلفيات:

أدنى نسبة من الضرر (الخدش) يكون 0.05 ٪ هو أدنى نسبة للضرر (قليلًا) مع 5 كج/ دقيقة معدل التغذية ، و 15 درجة حوض الغسيل و 50 الدورة في الدقيقة. بسرعة فرشاة في البرتقال أبوسورة. بالإضافة إلى ذلك، 0.05 ٪ هو أدنى نسبة الضرر الفاكة (بدون أعراض) مع 5 كج/ دقيقة معدل التغذية ، و 15 درجة حوض الغسيل و 40 الدورة في الدقيقة. بسرعة فرشاة للبطاطس نيفولا.

4- تحليل العكارة:

تحليل تعكر المياه يحدد الصلاحية لإعادة تدوير المياه واستخدامها مرة أخرى في عملية الغسيل. لذا ينبغي أن تصفي المياه المعكرة وذلك للتقليل من كمية المياه المستهلكة حيث كان استهلاك المياه في عملية الغسيل 95٪ و 1.11 ٪ من البرتقال صنف أبوسورة والبطاطس صنف نيفولا على التوالي.