WASHING WATER TURBIDITY AS INDICATOR TO FRUIT AND VEGETABLE WASHER EFFICIENCY

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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

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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 = (SR / SA) × 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.
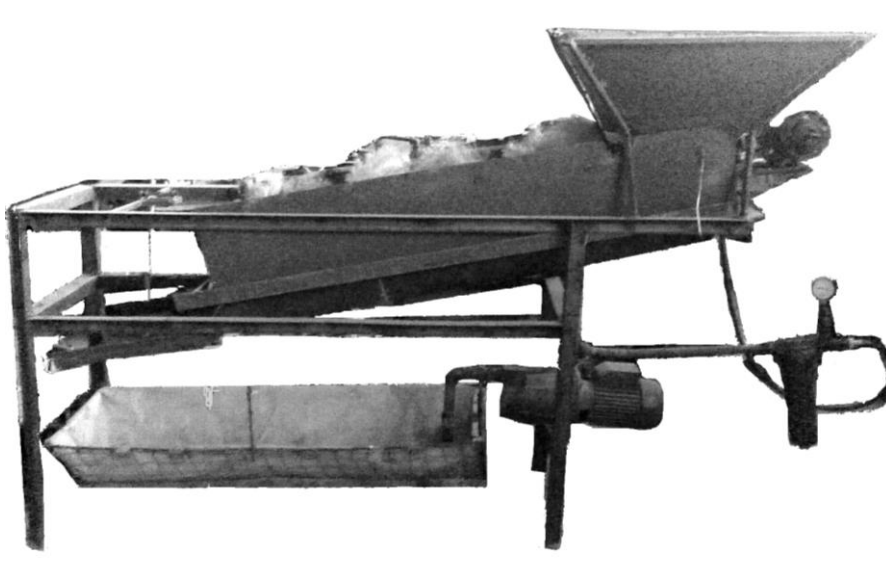
2.6. Washing basin.

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 m^3 (≈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.

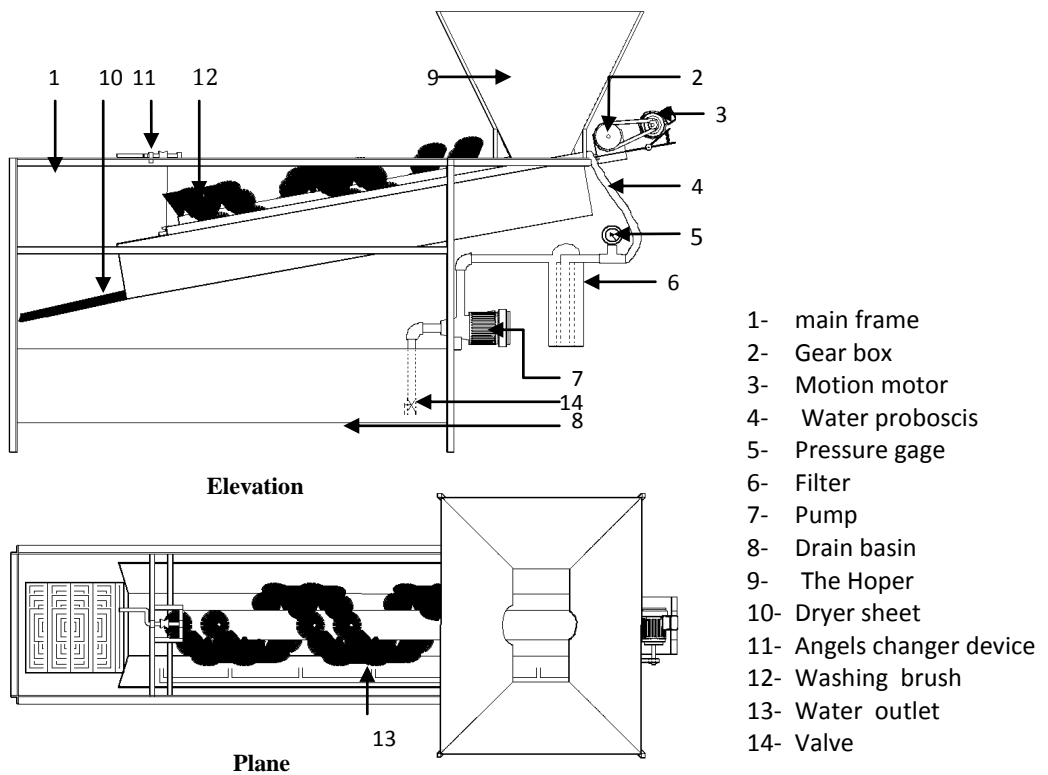Plat 1: Elevation feature of the washing machine.

Elevation

Plane

1- main frame
2- Gear box
3- Motion motor
4- Water proboscis
5- Pressure gage
6- Filter
7- Pump
8- Drain basin
9- The Hoper
10- Dryer sheet
11- Angels changer device
12- Washing brush
13- Water outlet
14- Valve

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.

$WE = (T / t) \times 100$, %. -- (2).

   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.)**

No.	Injury Categories	No. of fruits injured, %
1	No symptoms	0
2	Slight	< 2
3	Moderate	2 - 5
4	Severe	5 - 10
5	Extreme	> 10

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.
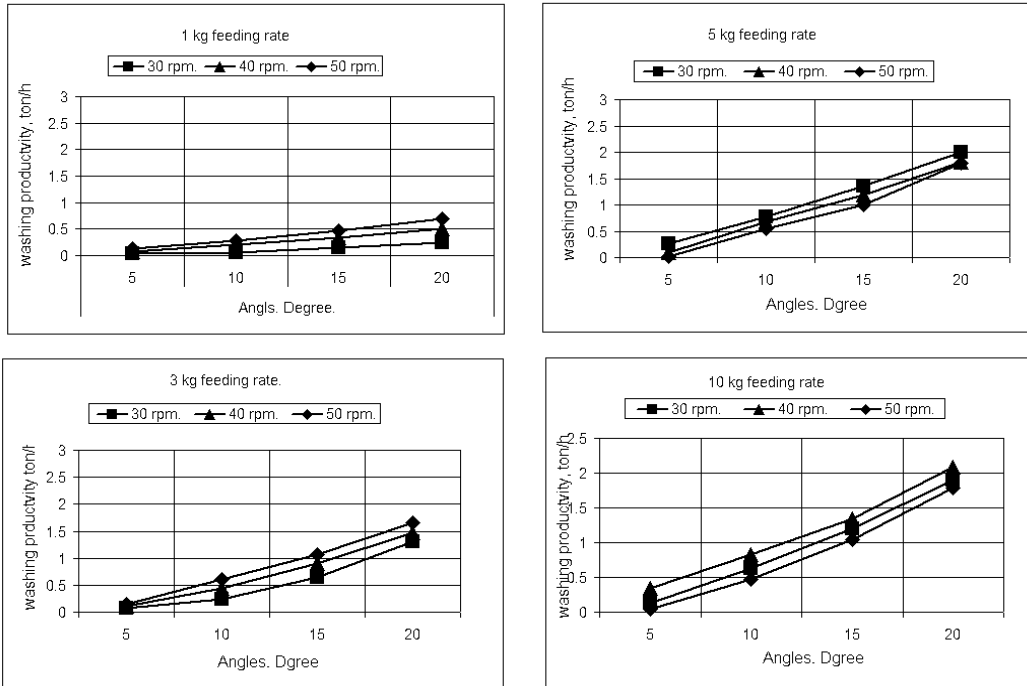
Fig. 2: Effect of brush speeds on washing productivity of Navel orange at different feeding rates and different angles.
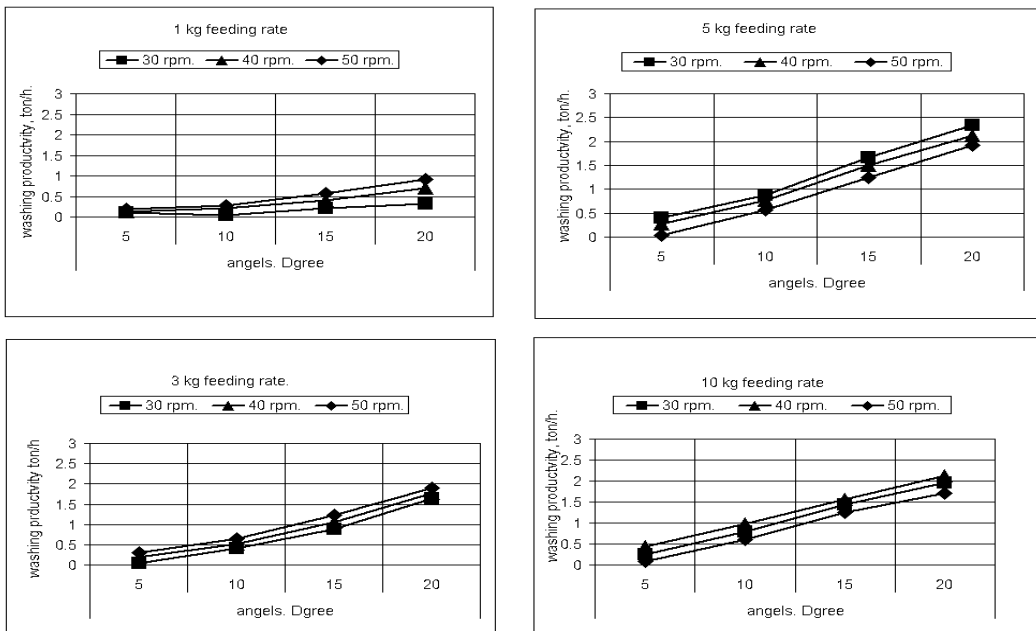

Fig. 3: Effect of brush speeds on washing productivity of Nicola potatoes at different feeding rates and different angles.
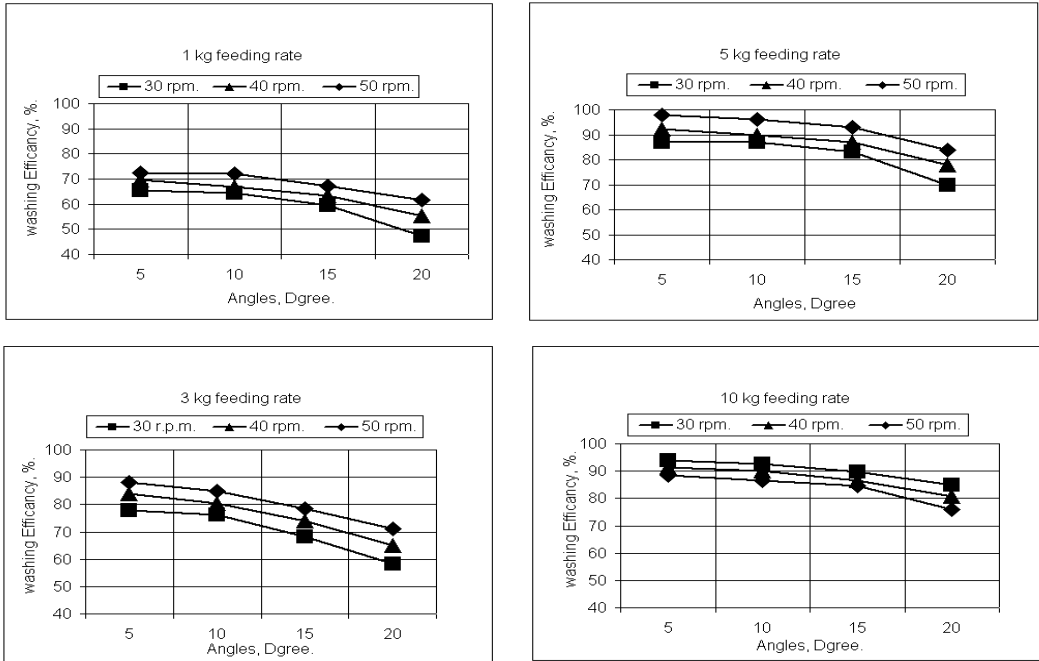
Fig. 4: Effect of brush speeds on washing Efficiency of Navel orange at different feeding rates and different angles.
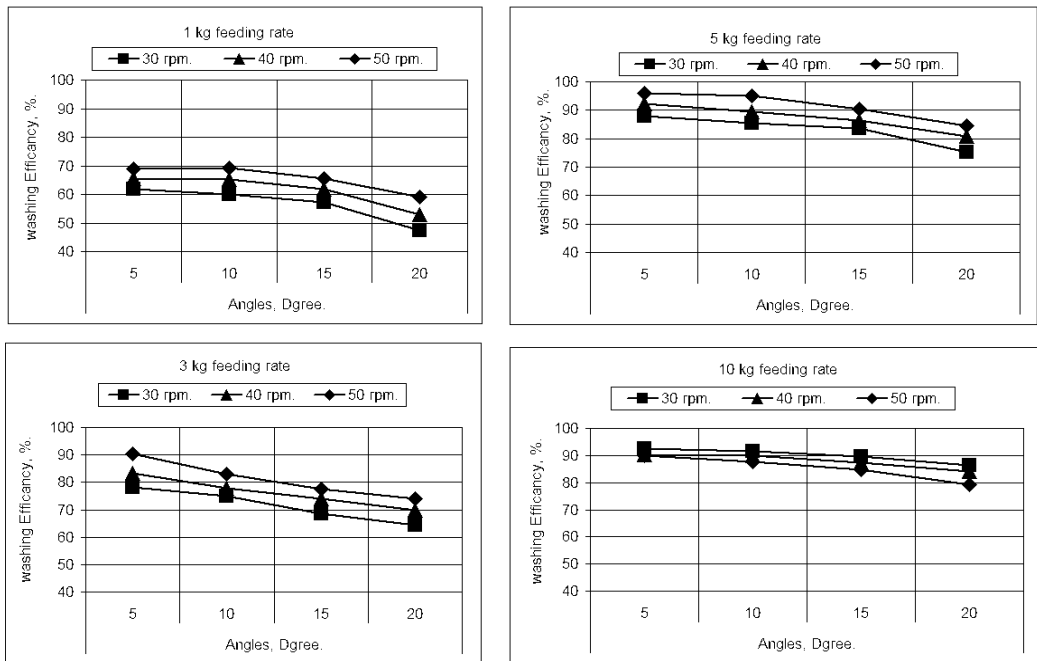

Fig. 5: Effect of brush speeds on washing Efficiency of Nicola potatoes at different feeding rates and different angles.
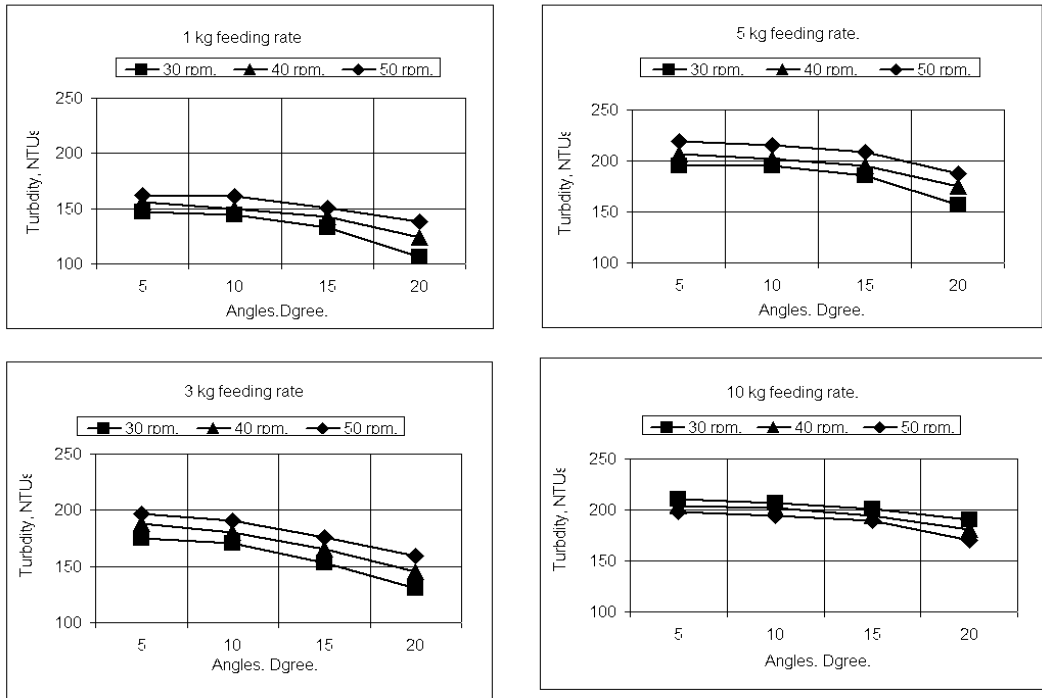
Fig. 6: Effect of brush speeds on water turbidity of Navel orange at different feeding rates and different angles.
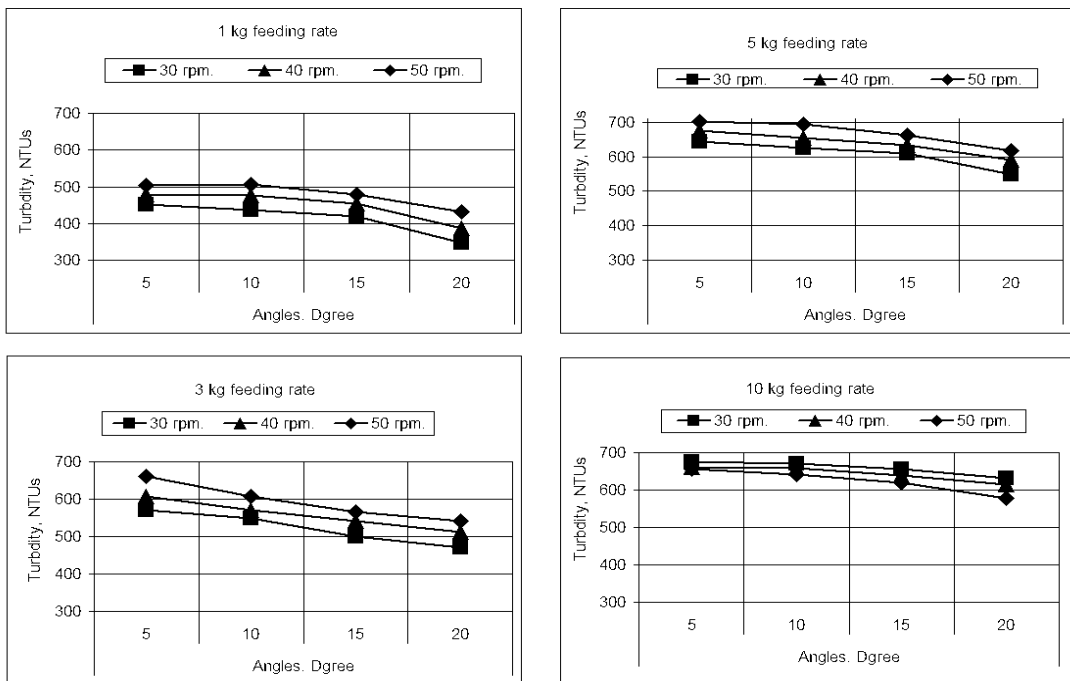

Fig. 7: Effect of brush speeds on water turbidity of Nicola potatoes at different feeding rates and different angles.
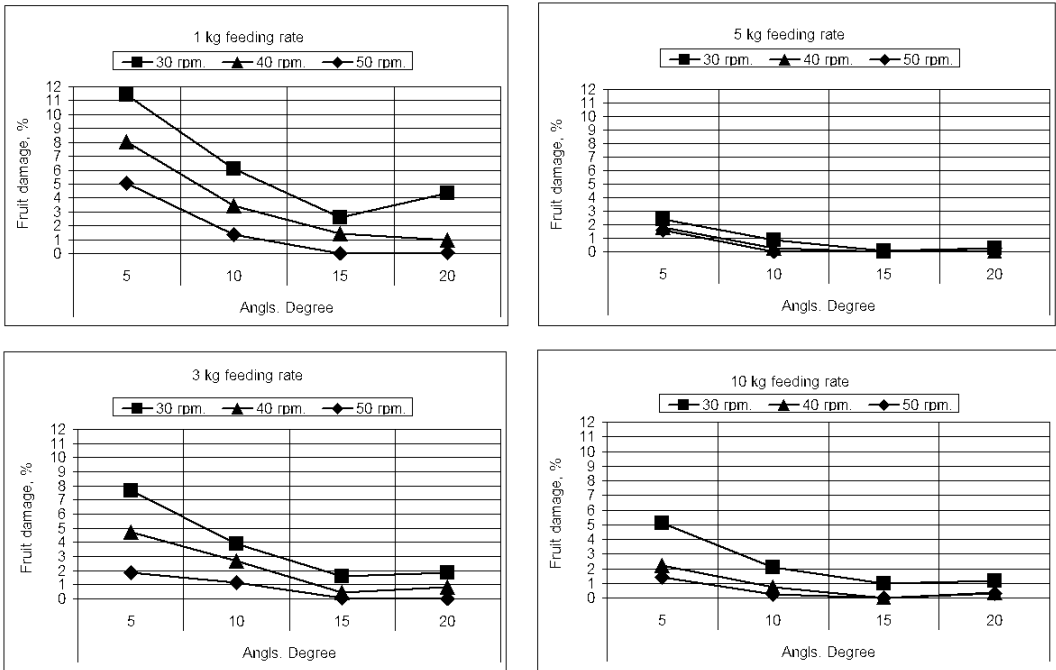
Fig. 8: Effect of brush speeds on Fruit damage of Navel orange at different feeding rates and different angles.
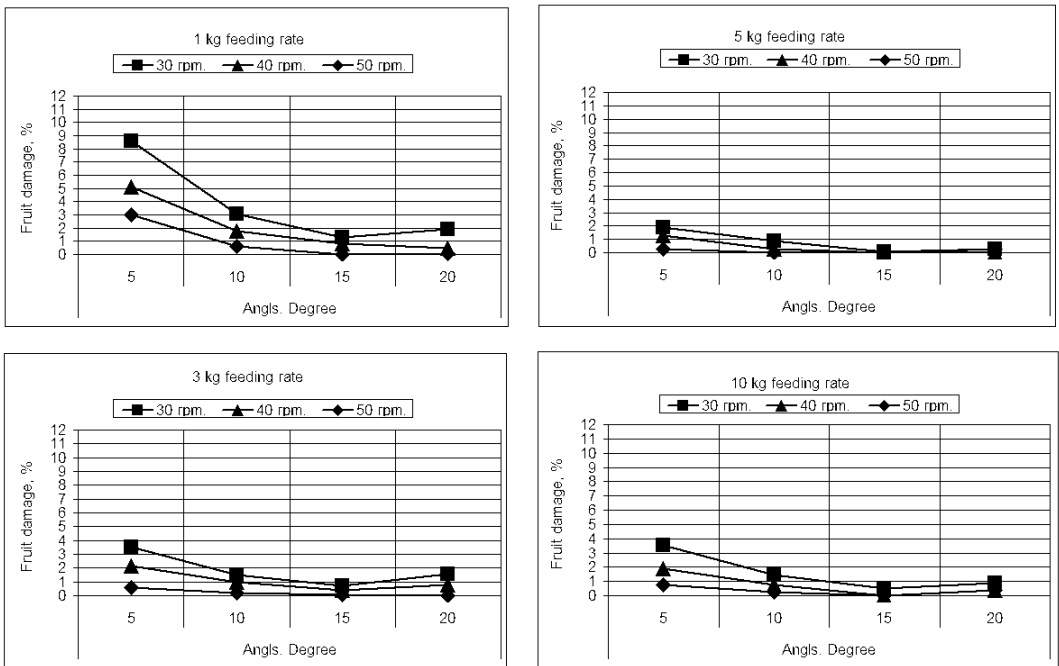

Fig. 9: Effect of brush speeds on Fruit damage of Nicola potatoes at different feeding rates and different angles.

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.

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<u>الملخص العربي</u>

عكارة ماء الغسيل كمؤشر لكفاءة غسالة الخضار والفاكهة

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عمرو محمد احمد[4]**

أجريت هذه الدراسة بهدف استغلال نسبة عكارة ماء الغسيل كمؤشر علي كفاءة غسيل الخضر
والفاكهة عن طريق تقدير العكارة في الماء بوحدات (NTUs) المستخدم في عملية الغسيل الآلي
مقارنة بالعكارة الموجودة في عينة قياسية عن طريق الغسيل اليدوي. وتزيد نسبة العكارة طرديا
مع كمية العوالق التي تؤثر علي شفافية الماء.وتم استخدام كلا من البرتقال أبو سره (من الفاكهة)
والبطاطس صنف نيقولا (من الخضر) في عملية الغسيل.
وأوضحت نتائج البحث إمكانية استخدام نسبة عكارة الماء وقياسها في تقدير كفاءة المنتج
المغسول بواسطة الغسيل الآلي.

● **نظرية تصميم آلة الغسيل.**

تم تصميم آلة الغسيل ممثلة في تحريك المنتج وتجاهل المواد الغير مرغوبة بواسطة الفرشاة
والماء حتى تتحرك قادمة إلى لوح التجفيف و تفريغها خارجا، وبالتالي فإن المواد الغير مرغوبة
تتم إزالتها من سطح المنتج و تنحل في الماء المصرف.
تمر المياه المصروفة بعد الغسيل من خلال فلتر يزيل المواد العالقة من المياه ثم يتم ضخ المياه
مرة أخرى عبر فتحات خروج الماء.
وكانت نتائج البحث ملخصة في النقاط التالية :

١ـ إنتاجية آلة الغسيل:

أفضل إنتاجية عند معدل التغذية ١٠ كج / دقيقة ، وزاوية حوض الغسيل ١٥ ° و سرعة
الفرشة ٤٠ دورة في الدقيقة وذلك بالنسبة إلى البرتقال أبوسرة كانت ١,٣٥ طن / ساعة بينما
كانت أفضل إنتاجية بالنسبة إلى البطاطس نيقولا عند معدل تغذية ١٠ كج / دقيقة ، وزاوية حوض
الغسيل ١٥ ° و سرعة الفرشة ٥٠ دورة في الدقيقة فكانت ١,٢٤ طن / ساعة.

٢ـ كفاءة آلة الغسيل:

أفضل كفاءة للغسيل عند معدل التغذية ٥ كج / دقيقة ، و زاوية حوض الغسيل ١٠ درجة و سرعة
فرشة الغسيل ٤٠ دورة في وذلك بالنسبة إلى البرتقال أبوسرة كانت ٩٠ ٪ بالإضافة إلى أفضل

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كفاءة للغسيل عند معدل التغذية٥ كج / دقيقة ، و زاوية حوض الغسيل ١٠ درجـة و سـرعة فرشـة الغسيل ٣٠ دورة في وذلك بالنسبة إلى البطاطس نيقولا كانت ٩٢,٤ ٪.

٣ـ نسبة التلفيات:

أدنى نسبة من الضرر (الخدش) يكون ٠,٠٥ ٪ هو أدنى نسبة للضـرر (قليلا) مـع ٥ كج / دقيقة معـدل التغذيـة ، و ١٥ درجـة حـوض الغسيل و ٥٠ دورة فـي الدقيقـة. بسـرعة فرشـاة للبرتقـال أبوسرة. بالإضـافة إلـى ذلك ، ٠ ٪ هو أدنى نسبة الضرر الفاكهة (بدون أعراض) مـع ٥ كج / دقيقة معدل التغذية ، و ١٥ درجة حوض الغسيل و ٤٠ دورة في الدقيقة. بسرعة فرشاة للبطاطس نيقولا.

٤ـ تحليل العكارة :

تحليل تعكر المياه يحدد الصلاحية لإعادة تدوير المياه واستخدامها مرة أخرى في عمليـة الغسيل. لذا ينبغي أن تصفي المياه المعكرة وذلك للتقليل من كميـة المياه المستهلكة حيث كـان استهلاك المياه في عملية الغسيل ٠,٩٥ و ١,١ م ٣/ طن من البرتقال صنف أبوسرة والبطـاطس صنف نيقولا على التوالي.