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SCIENTIFIC COMMUNICATION

QUALITY OF PITAIA FRUITS SUBMITTED TO FIELD BAGGING[1]

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ABSTRACT - In recent years, with the change in consumer profile, the demand for foods with low levels or even without pesticides has increased. Bagging fruits in the field is considered one of the oldest and effective phytosanitary practices, being an alternative to chemical control. The aim of the present work was to test some types of packaging in the bagging of pitaia fruits during their development in the plant in order to maintain quality. Red pitaia plant fruits [*Hylocereus undatus* (Haw.) Britton & Rose] five years post-planting were used. The experimental design used was random blocks, with 5 treatments, 4 repetitions and 10 fruits per plot. Treatments consisted of control (without bagging), newspaper bag, Kraft paper bag, waxed paper bag and Non-woven bag (NW). The following characteristics were evaluated: percentage of remaining fruits up to harvest; percentage of damaged fruits; fruit mass; longitudinal and transverse diameter; pulp yield; peel thickness; soluble solids content (SS); pH; titratable acidity (TA) and SS/TA ratio. There was no difference among treatments for most of the characteristics analyzed, except for percentage of remaining fruits on the plant and percentage of damaged fruits. Bagging does not alter the physical and chemical characteristics of red pitaia fruits. NW and newspaper bags are more effective in bagging pitaia fruits due to greater permanence in the fruit during its development in the plant.

Index terms: *Hylocereus undatus* (Haw.) Britton & Rose, packaging, post-harvest quality.

QUALIDADE DE FRUTOS DE PITAIA SUBMETIDOS AO ENSACAMENTO NO CAMPO

RESUMO – Nos últimos anos, com a mudança no perfil do consumidor, tem aumentado a exigência por alimentos com níveis reduzidos ou mesmo isentos de agrotóxicos. O ensacamento dos frutos no campo é considerado uma das práticas fitossanitárias mais antigas e eficazes, sendo uma alternativa ao uso do controle químico. Objetivou-se, no presente trabalho, testar alguns tipos de embalagem no ensacamento dos frutos de pitaia durante seu desenvolvimento na planta, visando à manutenção de sua qualidade. Foram utilizados frutos de plantas de pitaia-vermelha [*Hylocereus undatus* (Haw.) Britton & Rose] com cinco anos pós-plantio. O delineamento experimental utilizado foi em blocos casualizados, com 5 tratamentos, 4 repetições e 10 frutos por parcela. Os tratamentos foram constituídos da testemunha (sem ensacamento), saco de jornal, saco de papel Kraft, saco de papel-manteiga e saco de tecido não tecido (TNT). As seguintes características foram avaliadas: porcentagem de frutos remanescentes até à colheita, porcentagem de frutos danificados, massa dos frutos, diâmetro longitudinal e transversal, rendimento de polpa, espessura da casca, teor de sólidos solúveis (SS), pH, acidez titulável (AT) e relação SS/AT. Não houve diferença entre os tratamentos para a maioria das características analisadas, com exceção do percentual de frutos remanescentes na planta e do percentual de frutos danificados. O ensacamento não altera as características físicas e químicas de frutos de pitaia-vermelha. Sacos de TNT e jornal são mais eficientes no ensacamento de frutos de pitaia devido à maior permanência nos frutos durante seu desenvolvimento na planta.

Termos para indexação: *Hylocereus undatus* (Haw.) Britton & Rose, embalagem, qualidade pós-colheita.

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Fruits known as pitaia belong to the family Cactaceae. Currently, commercially exploited species correspond to *Hylocereus undatus* (red bark and white pulp), *Hylocereus costaricensis* (red bark and red pulp) and *Selenicereus megalanthus* (yellow bark and white pulp) (JUNQUEIRA et al., 2010).

Among the main problems that affect the quality of the pitaia fruits, those caused by pests stand out. It is observed that *Atta* and *Solenopsis* ants cause great damages to the cladodes, flowers and fruits. Irapuás (*Trigona spinipes*) can also cause great damage due to the depreciation of fruits for commercialization. The symptoms of the attack of these insects are mainly present in the bark of fruits, exposing pulp and damaging their commercial value. In addition, due to their attractiveness, it is common the attack of birds that feed on fruits, consuming their pulp.

According to Pereira et al. (2009), fruit bagging is considered one of the oldest and most effective phytosanitary practices, but with the emergence of insecticides and the reduction of family labor, it has been progressively replaced. In recent years, with changes in the consumer profile, particularly of those who consume fresh fruits, the demand for food with reduced levels or free of pesticides has increased. In this context, fruit bagging may be an effective alternative for the management of some pests (TEIXEIRA et al., 2011a).

When compared to the practice of chemical control, fruit bagging requires more investment in material, labor and time; however, the technique may reduce or even prevent the application of pesticides in orchards. Thus, fruits produced with this technique can be marketed to more demanding markets, favoring the cost-benefit ratio. In relation to pest management, it allows the harvesting of high-quality fruits, even under conditions of high population pressures, without the use of agrochemicals (TEIXEIRA et al., 2011b).

The type of material most suitable for fruit bagging is also the aim of many researchers. Coelho et al. (2008) worked with non-woven (NW), polypropylene, polyethylene and impermeable paper bags and verified that all materials were efficient as mechanical barrier to the attack of fruit flies in peach fruits. Malgarim and Mendes (2007) also obtained good results when using NW for the bagging of guava fruits. In persimmon, the material that presented the best result was newspaper sack (BIASI et al., 2007). In addition to the type of material, emphasis has been placed on the appropriate size of the fruit for bagging, as in the work conducted by Grassi et al. (2011) with loquat. Thus, the aim of the present work was to obtain pitaia with higher quality by bagging fruits in development in the field with some types of packages.

The experiment was carried out in the Department of Agriculture (DAG) of the Federal University of Lavras, Lavras - Minas Gerais, in the months of March and April 2012. The climate of the region is Cwb type, mild temperate (mesothermic), according to the Köeppen classification. Red pitaia fruits [*Hylocereus undatus* (Haw.) Britton & Rose] with five years post-planting, spaced 3 m x 3 m and supported on eucalypt mortars 1.8 m above the soil were used. Treatments used were: control (without bagging) (T1), 30 cm x 18 cm newspaper bags (T2), 36 cm x 16 cm Kraft paper bags (T3), 31 Cm x 14 cm paraffin waxed and transparent paper bags (T4) and 40 cm x 20 non-woven sacks (NW) (T5). All bags used in the bagging had closed bottom.

Unripe pitaia fruits were manually bagged 15 days after anthesis, when they presented approximately 7.0 cm of longitudinal diameter and 5.0 cm of transversal diameter. Fruits bagged with waxed paper, Kraft paper and NW were tied to the petiole with string, while for fruits bagged with newspaper, it was placed around the fruit and fixed with the aid of a stapler.

Fruits were harvested 45 days after anthesis, when fruit barks were reddish. After harvest, fruits were immediately taken to the Laboratory of Biochemistry of the Federal University of Lavras, where the following characteristics were evaluated: percentage of fruits that remained packed until the end of the experiment; percentage of damaged fruits, which were those with signs of attacks of birds and insects; fruit mass, using a semi-analytical scale; longitudinal and transversal diameter of fruits, measured using a digital caliper; pulp yield, separating the pulp from the bark and weighing only the pulp. To determine pulp yield, a simple three rule was used to obtain the pulp mass percentage in relation to the total fruit mass; bark thickness, measured using a digital caliper; soluble solids content determined using ATAGO manual refractometer, with results expressed in ^{o}Brix (AOAC, 2012); pH measured by a Marconi pH meter (PA200), which was read after mixing 1 g of pulp with 20 ml of water; titratable acidity (TA) measured by weighing 1 g of pulp and adding 20 ml of water, which after mixed were titrated with 0.1 N NaOH, with 0.1% phenolphthalein indicator and the results were expressed as grams of malic acid per 100 g of pulp (AOAC, 2012); SS/TA obtained by the ratio between soluble solids (SS) and titratable acidity (TA).

The experimental design was in randomized

blocks, with 5 treatments, 4 replicates and 10 fruits per plot. The results were submitted to analysis of variance, and the means were compared by the Tukey test at 5% probability, using the Sisvar statistical software. The percentage of fruits remaining until harvest was transformed into $\sqrt{x}$.

It was observed that bagging did not cause changes in mass, pulp yield, bark thickness, longitudinal and transverse diameter of fruits (Table 1).

Using different materials (NW, milky plastic and control) in the bagging of atemoya and sugar apple, Pereira et al. (2009) did not find differences among treatments for characteristics such as length and diameter of fruits, mass and pulp yield. However, for guava, fruit bagging with waxed paper, in addition to controlling fruit fly and weevil, improves the color of fruits, making them more attractive to fresh consumption (JUNQUEIRA et al., 1980). Santos et al. (2007) obtained higher weight of apples cv. 'Fuji Suprema' when fruits were bagged with waxed paper compared to control fruits (without bagging).

For characteristics soluble solids content, titratable acidity, pH and SS/TA ratio, no difference was found among treatments (Table 2), and it could be inferred that bagging fruits with materials used in this experiment does not influence the quality of pitaia fruits. This result can be considered satisfactory, since it was concluded that bagging would be an adequate way to protect fruits with some types of packaging used in this procedure.

The content of soluble solids and acidity found in this experiment were similar to those obtained by Moreira et al. (2011) for red pitaia. In a study with red pitaia at different maturation stages, Enciso et al. (2011) found content of soluble solids for fruits at complete maturation stage around 11 and 12 ^{o}Brix; however, the titratable acidity found was slightly higher than that obtained in this experiment (0.63% malic acid).

Teixeira et al. (2011a) working with 'Imperial Gala' apple fruits bagged with different materials (plastic bags, NW bags and control) also found no differences among treatments for content of soluble solids, in contrast the total titratable acidity, which was higher in fruits bagged with NW bags.

Coelho et al. (2008) tested different materials (NW, impermeable paper, milky polyethylene, transparent polypropylene) in peach bagging and also found no significant differences in the diameter and average weight of fruits when submitted to bagging with different materials and for chemical characteristics such as pH, SS, TA and SS/TA ratio, concluding that bagging also had no influence.

It was verified that the percentage of fruits remaining until harvest was higher in treatments packed with NW and newspaper, and all fruits from NW treatment remained packed until the end of the experiment (Table 3). This material stood out among the others, because the fruits remained protected throughout the development period of fruits. Newspaper bag also stood out, reaching an average of 74.59% of fruits protected until the end of the experiment; however, as newspaper bags were handmade and sealed with the help of a stapler, it was more difficult to pack fruits with this material. Considering that the price of the newspaper is lower than that of the NW bag, the option of bagging pitaia with newspaper may be a more viable for most producers. It is also important to highlight that the other packages used were not efficient in protecting fruits because a great number of them damaged and fell during fruit development because materials were fragile and easily to tear with the occurrence of rainfall and winds. Nascimento et al. (2011) found that bagging fruits with white NW for protection against fruit fly attack was efficient. Hernandes et al. (2013) evaluated different materials for guava bagging to protect against fruit fly attack and concluded that NW bag was the most efficient material in fruit protection, presenting only 4% of damaged fruits.

In relation to the percentage of damaged fruits, it is verified that fruits packed with NW were not damaged, therefore, at the end of the experiment, 100% of fruits remained intact in plants. In contrast, 54.40% of control fruits (unprotected) were damaged. Treatments in which fruits were bagged with newspaper, kraft paper and waxed paper did not differ statistically and presented 16.45%, 19.10% and 16.27% of damaged fruits, respectively. The main damages suffered by fruits verified in the work were caused by the attack of birds, irapuá and leaf-cutting ants.

Pitaia fruits are very sensitive in pre and post harvest. The friction of fruits by the wind action can depreciate them at the moment of marketing, in addition to the exposure to insects and other agents that can cause some damage to fruits. Therefore, the use of materials that help protecting the physical characteristics of fruits is considered an important practice to guarantee higher prices in the marketing of some types of products. However, the cost/benefit ratio of the use of bagging materials in pitaia fruits should be analyzed. The results obtained may offer alternatives for the use of different bagging materials, without compromising the quality attributes of products.

However, NW allowed the protection of pitaia fruits and it may be recommended as the best option among the different types of bagging materials. Alternatively, newspaper may also be used, although its persistence in fruits is lower than that of NW.

TABLE 1- Average mass, pulp yield (PY), bark thickness (BT), longitudinal (LD) and transversal diameter (TD) of pitaia fruits bagged in field with different packaging materials. Lavras-MG, 2015.

Treatments	Mass (g)	PY (%)	BT (mm)	LD (cm)	TD (cm)
Control	223.20a	56.95a	4.19a	80.61a	67.68a
Newspaper	209.58a	49.15a	4.38a	78.39a	66.60a
Kraft paper	245.42a	61.18a	4.40a	81.09a	70.91a
Waxed paper	252.20a	52.33a	4.86a	85.67a	71.10a
NW	220.57a	52.24a	4.43a	81.02a	67.84a
VC (%)	20.11	14.51	18.08	8.68	6.62

Averages followed by the same lowercase letter in column do not differ from each other by the Tukey test at 5% probability level.

TABLE 2- Average content of soluble solids, pH, acidity and SS/TA ratio of pitaia fruits bagged in field with different packaging materials. Lavras-MG, 2015.

Treatments	SS (°Brix)	pH	Titratable acidity (g malic acid 100 g of pulp $^{-1}$)	Ratio
Control	13.16a	4.62a	0.29a	45.64a
Newspaper	11.83a	4.48a	0.35a	39.17a
Kraft paper	13.00a	4.49a	0.33a	41.57a
Waxed paper	12.50a	4.47a	0.33a	38.43a
NW	12.50a	4.56a	0.29a	43.77a
VC (%)	6.60	3.14	18.63	15.15

Averages followed by the same lowercase letter in column do not differ from each other by the Tukey test at 5% probability level

TABLE 3- Fruits remaining until harvest (FR) and damaged pitaia fruits (DF) after field bagging with different packages. Lavras-MG, 2015.

Treatments	* FR (%)	DF (%)
Control	45.60b	54.40a
Newspaper	74.59ab	16.45b
Kraft paper	56.97b	19.10b
Waxed paper	45.06b	16.27b
NW	100.0a	0.0c
VC (%)	9.06	17.06

Averages followed by the same lowercase letter in column do not differ from each other by the Tukey test at 5% probability level
* Data transformed into √x.

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