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ISSN 1982-3797

International Conference of Agricultural Engineering
XXXVII Brazilian Congress of Agricultural Engineering
International Livestock Environment Symposium - ILES VIII

August 31st to September 4th, 2008
Iguassu Falls City - Brazil

INTERNATIONAL CONFERENCE OF AGRICULTURAL ENGINEERING
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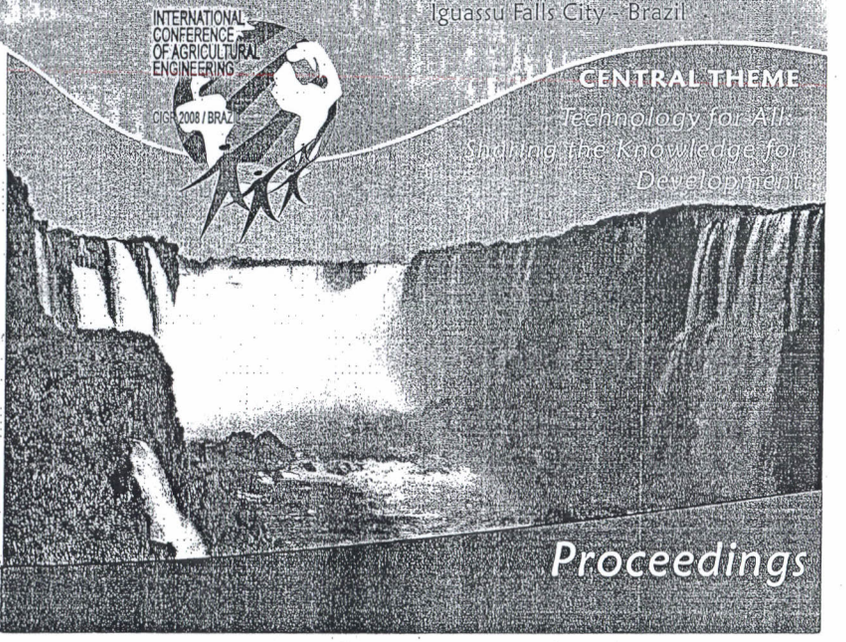

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XXXVII Congresso Brasileiro de Engenharia Agrícola

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EVALUATION OF IMPACTS IN POTATO PACKING LINE

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Presented at
CIGR - INTERNATIONAL CONFERENCE OF AGRICULTURAL ENGINEERING
XXXVII Brazilian Congress of Agricultural Engineering - 2008
Brazil, August 31 to September 4, 2008

ABSTRACT: The reduction of mechanical damage is an important factor for fresh produce quality improvement. Bruise damage to potato tubers appears as a result of impacts and compression during operations performed in packinghouses using machines. The objective of this research was to determine critical points for impact in a potato packing line at Minas Gerais state, Brazil. An instrumented sphere (IS) Techmark, Inc., Lansing, (70mm) was used to measure impact intensities at each transfer point in a packing line. The IS was carried with the fruit over one or more transfer points while the elapsed time was recorded at each point using a stopwatch. Impacts were measured as maximum acceleration (MA) in G (Gravity=9.81 $m.s^{-2}$). The transfer points with maximum acceleration were at classification entry and drying exit, showing the values of 164.95 and 135.68 G respectively.

KEYWORDS: Instrumented sphere, Mechanical Damage, Quality

INTRODUCTION: Brazilian potatoes production in 2007 was 1,637,446 ton (IBGE, 2007). However, it is estimated that the potato post-harvest losses in Brazil are about 30%, due to mainly inadequate handling conditions (VILELA *et al.*, 2003). The mechanical damage that occurs during potato harvesting and handling is a relevant cause of quality loss in value, increasing diseases incidence during storage. In Brazil there are various potato post-harvest handling systems and the most common is washing, sorting and classifying in packing-houses (HENZ and BRUNE, 2004). Therefore, it is very important to determined the packing line transfer points to reduce losses by mechanical injury. It is recommended to adjust the sorting equipment to prevent more serious injuries and impacts to potato tubers. The instrumented sphere has been used as a device by researches to measure the maximum acceleration (G = 9.81 m/s^2) in packing lines transfer points for potato (Hyde *et al.*, 1992): orange (Miller and Wagner, 1991); avocado, papaya and pineapple (TIM and Brown, 1991) and tomato (HYDE et al., 1992; FERREIRA et al., 2005). MATHEW and HYDE (1997) using the instrumented sphere impact for evaluation determined impacts threshold for bruising limit in potatoes. The main goal of this work was to measure impact intensity at critical points in a potato packingline using an instrumented sphere (76 mm, Techmark, Inc., Lansing, Michigan, USA).

METHODOLOGY: The impact magnitudes at transfer points were measured in a potato packing line located in the State of Minas Gerais, Brazil. An instrumented sphere Techmark, Inc., Lansing, USA (76 mm) was used. The product was dumped in a water tank with capacity of 53 m^3, approximately. Potatoes were transported in 60 kg bags and placed manually in the tank. After that, the potato tubers were passed through an elevator and washed with nylon and coconut fiber brushes and PVC rolls. The next steps were drying, primary selection, classification, second selection and packaging. The sphere instrumented was placed on the produce receiving stage, which was operating in its normal capacity, and moved together with the potatoes, following their flow until packing stage. It was measured the fall heights at the transfer points along the equipment. The measured height was a

perpendicular distance from the fall contact point to the exact location for the first tuber contact point when dropping. A precision chronometer was used to assess the elapse time at each step, as well as the time to complete all line process. The measurements were repeated 5 times. After experiments, the sphere data was transferred to a microcomputer. The pre-established range for impact level measuring was from 15 to 500 G. Average impact values, obtained at the transfer points of each beneficiary unit tested were correlated with the maximum acceleration (MA) ($G = 9.81\ m / s^2$).

RESULTS AND DISCUSSION: The highest average value for impact (164 G) was found at transfer point of classification entry (Table 1), where presented the largest fall height (0.55 m), though there was a canvas curtain to reduce the impact. Other high impact average values occurred in drying exit and in process final stages. At the product packaging, recorded data varied according to the bag packaging filling and maximum acceleration at this transfer point ranged from 61.1 to 275.8 G. The higher value occurred when the potato bag was empty. Considering individual values, it was observed a wide range between the lowest and highest value (Figure 1). In this case, highest individual measurements occurred at cleaning entry, drying exit and classification entry. These transfer points showed high heights fall, but often the impact intensity was reduced due to product high flow. FERRREIRA and NETTO (2007), analyzing two beneficiary units in the state of Sao Paulo, have found values of 122.4 G at the packaging stage and of 191 G in the receiving stage of an other equipment.

TABLE 1. Values of maximum acceleration in transfer points

Transfer point	Fall height [m]	Average maximum acceleration [G, m/s²]	Highest value recorded [G, m/s²]	Standard deviation
1 - Receiving	2.70	114.1 *(6)**	147.1	29.6
2 - Tank exit	-	90.4 *(9)*	120.1	22.0
3 - Pipeline exit	-	97.1 *(8)*	143.1	43.4
4 - Cleaning entry	0.37	110.9 *(7)*	244.7	77.5
5 - Cleaning exit	-	65.8 *(11)*	83.2	13.0
6 - Drying entry	-	73.2 *(10)*	132.5	33.8
7 - Drying exit	0.28	135.7 *(2)*	229.1	56.0
8 - Classification entry	0.67	164.9 *(1)*	207.5	30.9
9 - Selection entry	0.43	116.7 *(5)*	199.3	47.8
10 - Selection exit	0.75	133.5 *(4)*	151.9	8.6
11 - Packaging	0.82	134.8 *(3)*	275.8	60.9

*Indication of decreasing average values sorting order

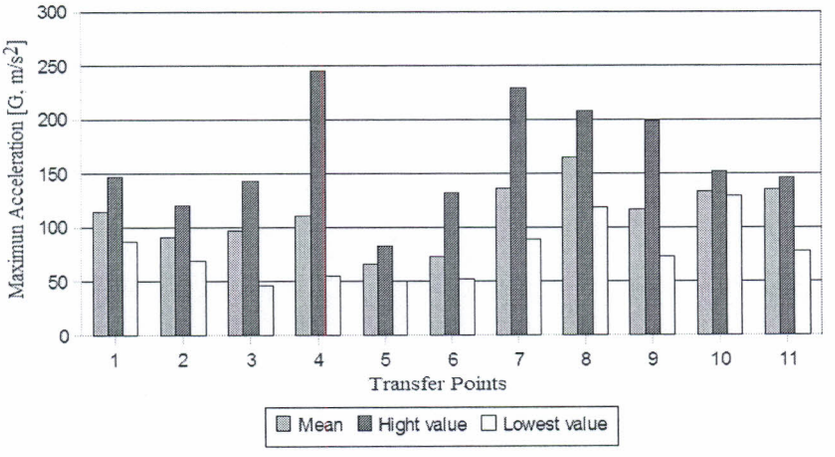

FIGURE 1. Average accelerations (G) measured at transfer points

Regarding impacts recorded at packing line, at the cleaning stage occurred 49.6% of impacts up to 30 G and 26.6% of the impacts in the range from 30 to 50 G (Table 2). From the pipeline exit to the cleaning entry were found 17.3% of the impacts in the range from 50 to 100 G, and 33.3% were higher than 150 G, which registered a value of 449.8 G at this stage (Table 3). When the potato was elevated to the cleaning stage, dropped from taliscas and suffered a fall of up to 3.60 m tall. From the selection exit to the packaging, 16% of impacts were between 100 and 150 G (Table 2).

TABLE 2. Percentage of impacts on packing line steps

Impact	Packing line stage between two transfer points *											
range (G)	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11	Total
< 30	1.9	2.1	11.6	**49.6****	3.9	2.1	2.0	13.1	10.9	2.8	0.0	100
30 - 50	6.8	3.0	17.5	**26.6**	8.4	3.4	3.8	13.3	14.4	2.7	0.0	100
50 -100	9.8	8.3	**17.3**	16.5	11.3	6.0	7.5	6.0	12.8	3.8	0.8	100
100 - 150	12.0	12.0	12.0	4.0	0.0	4.0	12.0	4.0	8.0	**16.0**	**16.0**	100
>150	0.0	0.0	**33.3**	8.3	0.0	8.3	8.3	25.0	8.3	8.3	0.0	100

* Transfer points: 1 - Receiving; 2 - Tank exit; 3 - Pipeline exit; 4 - Cleaning entry; 5 - Cleaning exit; 6 - Drying entry; 7 - Drying exit; 8 - Classification entry; 9 - Selection entry; 10 - Selection exit; 11 – Packaging. **Highest value in bold.

TABLE 3. Values of maximum acceleration recorded between each transfer point

Stage	Mean	Standard deviation	Maximum acceleration [G, m/s^2]
1-2	46.3	29.0	147.1
2-3	42.3	27.1	120.1
3-4	37.7	40.9	449.8
4-5	23.8	14.1	244.7
5-6	33.8	16.5	83.2
6-7	38.3	29.7	160.4
7-8	48.5	40.7	229.1
8-9	29.7	24.5	207.5
9-10	31.6	23.0	199.3
10-11	42.7	37.4	151.9

In this study it was not evaluated physical damage on the potato. MATHEW and HYDE (1997) found that potatoes at a temperature of 21°C, showed no damage when dropped on metal from height up to 50 mm and maximum acceleration of 122 G. When the height is increased to 100 mm and maximum acceleration of 181 G, an external damage occurred in 10% of potatoes. BARITELLE and HYDE (2001) determined experimentally that the height limit, where 20% of tubers showed damage, is 125 mm in a temperature of 20°C. This variation of recommendations among other reasons occurs due to variety used and produce initial quality,. At the present research, the steps of drying exit, classification entry, selection exit and packaging had fall height between 280 mm and 820 mm, greater values than limits mentioned in literature. Suggestions to reduce the values of impact would be protect rigid areas with soft pads or reduce the heights of falls.

CONCLUSIONS: The elevated acceleration values at some transfer points occurs due to a combination of high height falls and use of rigid metal surfaces. So it is recommended to decrease fall height and/or the introduction of soft pads. Convering transfer points with soft pads is a more immediate solution, while the decrease in fall height, in a first analysis, can affect the product flow velocity, and also demands a higher investment.

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