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Evaluation of a Walnut Huller

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Abstract

Walnut is one of the high yielding crops in horticultural production, and establishment of walnut orchards is growing. Yet despite Iran's being the second largest producer of walnuts in the world, this country does not play a significant role in walnut export. This gap is most affected by the need to mechanize the harvesting process. This case is more understandable when can construct a new device with greater efficiency in comparison of the existing mechanical systems. In this article, a walnut huller built on the Abouraihan campus of the University of Tehran is evaluated, with Rotational speed, time and brush distance being optimized to make the best quality of hulling process. The results indicate that increasing the rotational speed, increases the amount of walnuts hulled but that the percentage of damaged nuts also increases. If, at a constant rotational speed, the distance between abrasive brushes is reduced, the amounts of nuts hulled and damaged are raised but the degree of hulling is greater than degree of injury. Also, if the distance between abrasive brushes and the rotational speed are decreased, the peeling rate is increased while the damage rate is decreased.

Keywords: Evaluation, Green husk, Huller, Walnuts.

Introduction

Post-harvest processing of agricultural products, in addition to reducing crop losses and expenses related to transportation, can increase product quality, thus adding value to crops and increasing their export. In the case of walnuts, quickly removing the green husk and drying are important post-harvest processing steps. The presence of tannins in the husks of walnuts, which are readily formed on exposure to air, causes shell blackening and hastens the change in kernel color from white to yellow or light brown. Harvested walnuts have a relatively high (30%) moisture content while a moisture content of 8% is needed for storage (Khir *et al.*, 2011; Rajabipour *et al.*, 2010). Obviously, traditional methods for hulling walnuts are not sufficient to meet the enormous volume walnut production.

In order to achieve a proper understanding of the hulling process and also to design an efficient walnut huller, an accurate study of the walnut and its green husk is required (Xu *et al.*, 2012). Therefore, the use of machines that are suitable to a variety of Persian walnut cultivars would be desirable. Walnut has a variety of uses in the food, industrial, pharmaceutical and cosmetics fields (Iso *et al.*, 2002; Çağlarırmak, 2003; Ozkan and Koyuncu, 2005; Colarič *et al.*, 2006; Ozcan, 2009; Bakkalbaşı *et al.*, 2012). Valuable studies have been performed in the field of food science and have demonstrated the positive effects of walnuts in human health. For example, the walnut has positive effects in lowering cholesterol (it is necessary to mechanize andincrease the efficiency of the harvesting and post

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harvesting processes of walnuts. In order to enhance the performance an efficiency of the existing devices, it is necessary to evaluate the performance of devices that are made beforehand.

Materials and Methods

The walnut huller machine evaluated here was built on the Abouraihan campus of the University of Tehran (Chegini and Makarichian, 2014). To evaluate this device, the rotational speeds of abrasive brushes and the distances between them and the grooved cylinder were selected so as to maximize the percentage of nuts hulled and to minimize the degree of damage. In order th achieve this goal, the rotational speeds were 263, 368 and 473 rpm and also the distance between abrasive brushes were chosen 12 and 16 mm. time of tests are divided to three groups so 30, 60 and 12 seconds. Six combinations of speed and distance were evaluated, each test was performed in replicates of three and the percentages of whole peeled (hulled) walnuts, unpeeled walnuts and damaged walnuts were found. The quantity of walnuts in each tests are different and therefor 25, 50 and 75 walnuts were used in different combinations. The walnuts used were the Chandler variety and were obtained from the Tuyserkan Research Institution. Because the performance intensities were dissimilar, different durations of time were used in each test.

Results

Results of quality evaluation and evaluation of performance capacity

The effect of a rotational speed of 473 rpm and a distance of 12 mm between abrasive brushes and grooved cylinder on the quality of peeling at three times (10, 20 and 30 seconds), each of which test was replicated three times (Fig. 1).

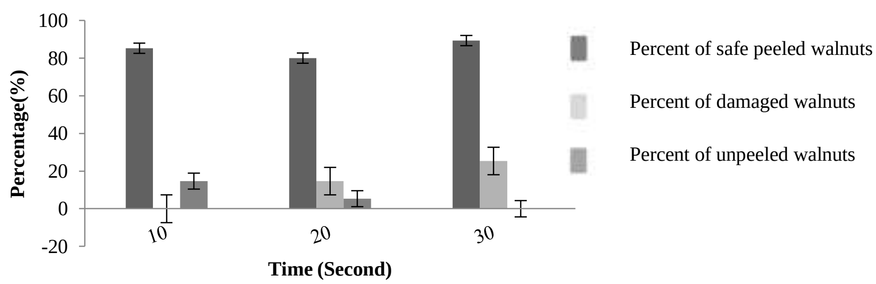

Fig. 1. Effect of a speed of 473 rpm and a distance of 12 mm on shelling quality

The effect of a rotational speed of 473 rpm and a distance 16 mm between abrasive brushes and grooved cylinder on quality of peeling in three times (10, 20 and 30 seconds), each of which test was was replicated three times (Fig. 2).

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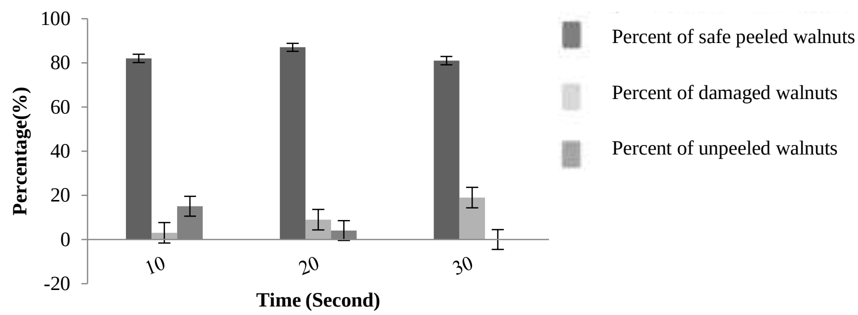

Fig. 2. Effect of a rotational speed of 473 rpm and a distance of 16 mm on shelling quality.

The effect of a rotational speed of 368 rpm and a distance of 12 mm between abrasive brushes and grooved cylinder on the quality of peeling at six times (10, 20, 30, 40, 50 and 60 seconds), each of which test was replicated three times (Fig. 3).

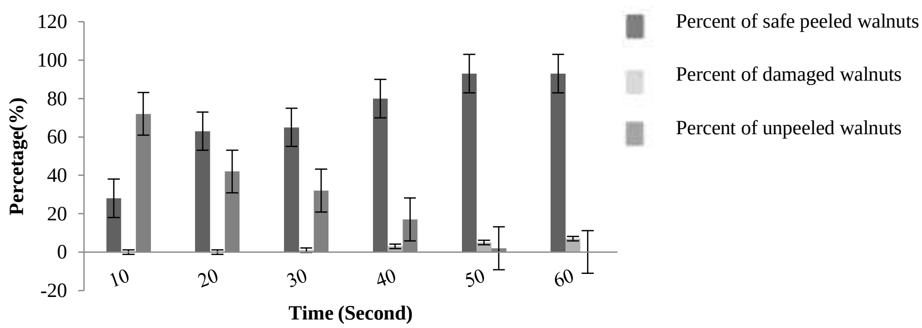

Fig.3. Effect of 368 rpm rotational speed and 12 mm distance on shelling quality

at six times (10, 20, 30, 40, 50 and 60 seconds), each of which test was replicated three times under effect of a rotational speed of 368 rpm and a distance of 16 mm between abrasive brushes and grooved cylinder on the quality of peeling (Fig. 4).

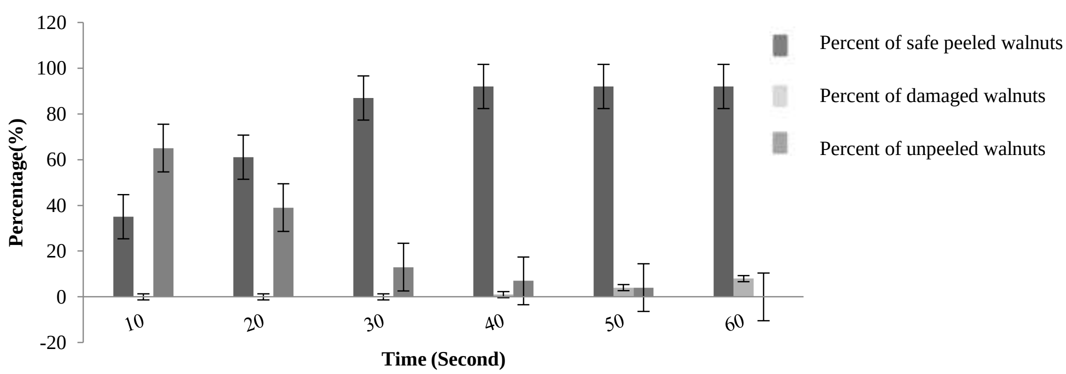

Fig. 4. Effect of arotational speed of 368 rpm and a distance of 16 mm on shelling quality

The effect of a rotational speed of 263 rpm and a distance of 12 mm between abrasive brushes and grooved cylinder on quality of peeling at nine times (10, 20, 30, 40, 50, 60, 80, 100 and 120 seconds), each of which test was replicated three times (Fig. 5). Also, Fig.6, shows the effect of a rotational speed of 263 rpm and a distance of 16 mm between abrasive brushes and grooved cylinder on the quality of peeling at nine times (10, 20, 30, 40, 50, 60, 80, 100 and 120 seconds), each of which test was replicated three times

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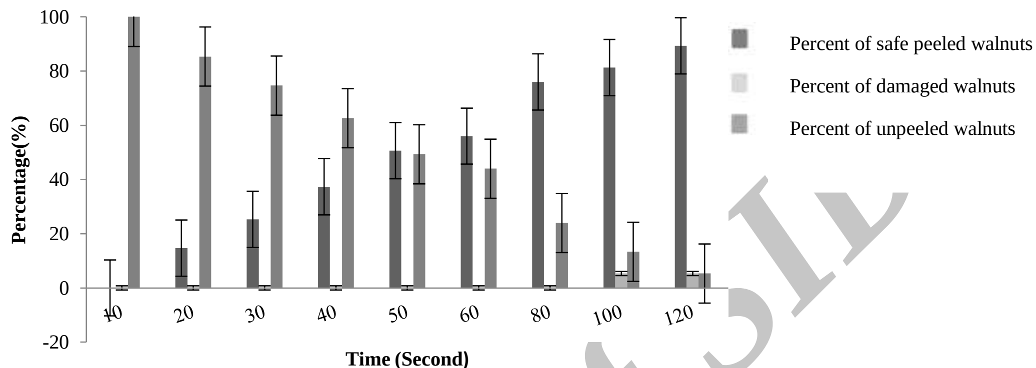

Fig. 5. Effect of a rotational speed of 263 rpm and a distance of 12 mm on shelling quality.

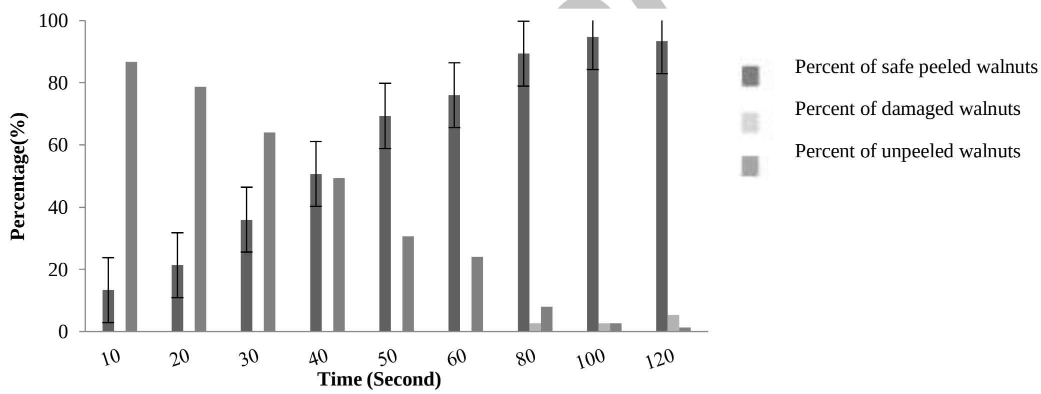

Fig. 6. Effect of a rotational speed of 263 rpm and a distance of 16 mm on shelling quality.

It worth mentioning that Fig. 7 shows the effect of the rotational speed of the abrasive brushes on peeling quality, assuming a constant distance of 12 mm between the abrasive brushes and the grooved cylinder.

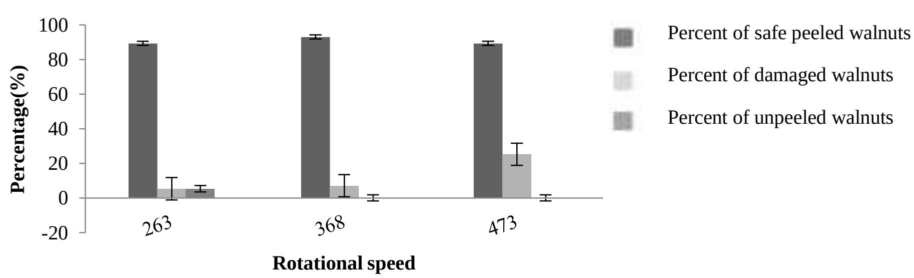

Fig. 7. Effect of different rotational speeds on shelling quality at a distance of 12 mm.

As seen in figure 8, these experiments also show the effect of a rotational speed of the abrasive brushes on peeling quality at a constant distance of 16 mm between the abrasive brushes and the grooved cylinder. Figure 9 shows effect of distance between abrasive brushes and grooved cylinder on the peeling quality at a constant rotational speed of 473 rpm, and Figure 10 shows effect of distance between abrasive brushes and grooved cylinder on peeling quality at a constant rotational speed of 368 rpm for the abrasive brushes.

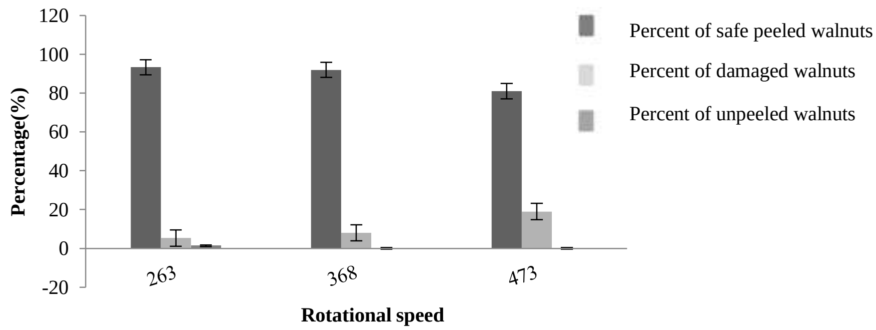

Fig. 8. Effect of different rotational speeds on shelling quality at a distance of 16 mm

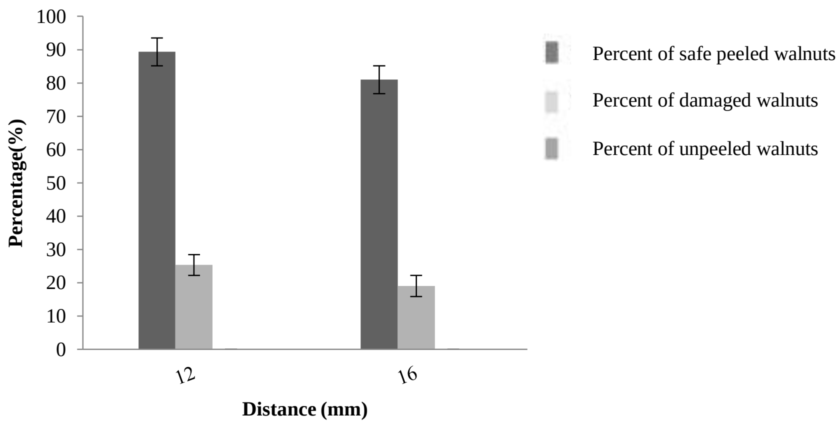

Fig. 9. Effect of different distances on shelling quality at a rotational speed of 473 rpm

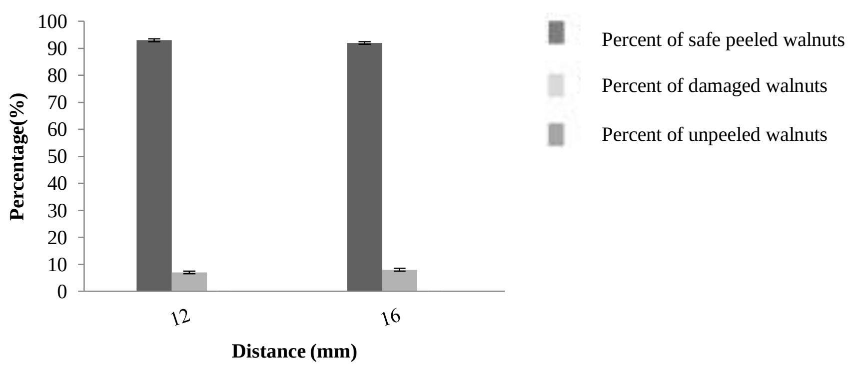

Fig. 10. Effect of different brush distances on shelling quality at a rotational speed of 368 rpm.

The effect of distance between abrasive brushes and grooved cylinder on peeling quality at a constant rotational speed of 263 rpm for abrassive brushes (Fig. 11).

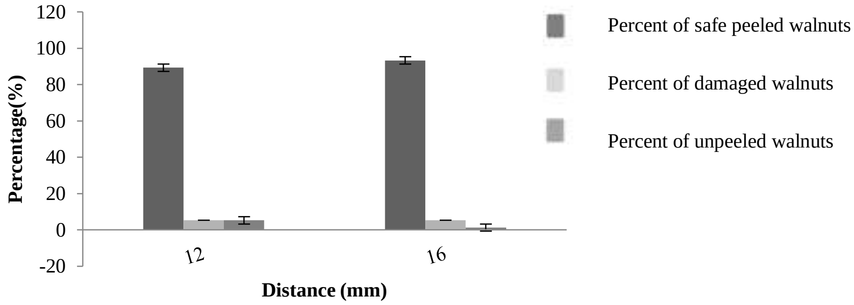

Fig. 11. Effect of different distances on shelling quality at a rotational speed of 263 rpm.

The effect of walnut quantity (25, 50 and 75) on peeling quality is shown at a rotational speed of 368 rpm, a distance of 16 mm and a time duration of 60 seconds (Fig. 12). Also, Fig. 13 shows effect of walnuts quantity (25, 50 and 75) on peeling quality at a rotational speed of 368 rpm, a distance of 12 mm and a time duration of 60 seconds.

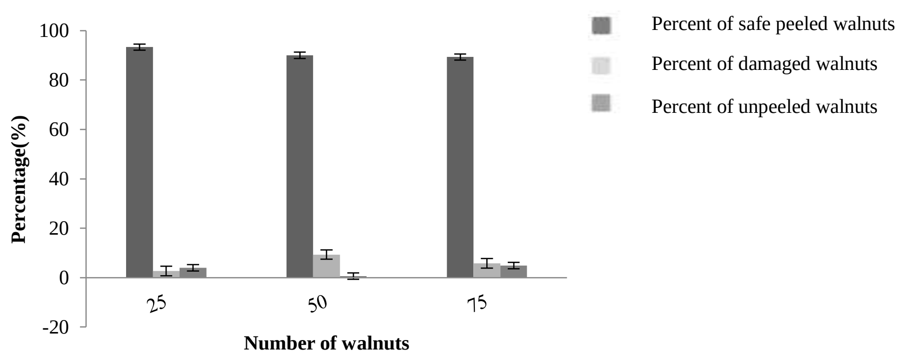

Fig. 12. Effect of walnut quantity on shelling quality with selected conditions (368 rpm rotational speed and 16 mm distance in 60 seconds).

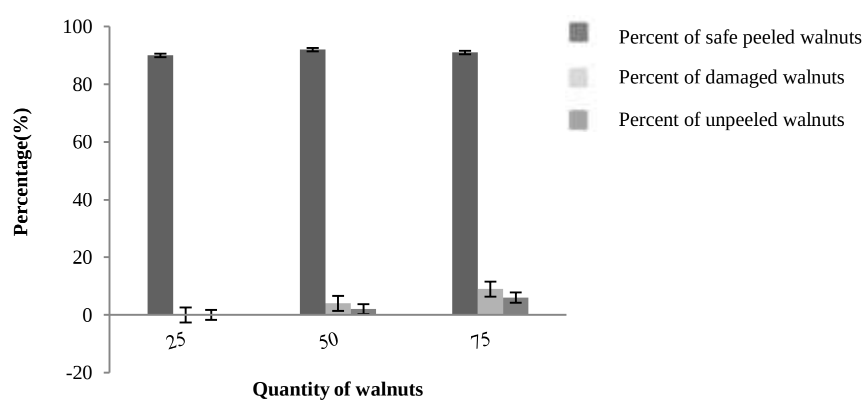

Fig. 13. Effect of walnut quantitys on shelling quality with selected conditions (368 rpm rotational speed and 12 mm distance in 60 seconds).

According to the results the best results were obtained when the rotational speed, distance and quantity of walnuts were 368 rpm, 16 mm, and 25 to 50 nuts, respectively. It should be noted that the duration of this combination was 60 seconds.

Statistical analysis

For statistical analysis of data, SPSS software and finally two-way ANOVA method was used. In two-way ANOVA, the data are classified according to two factors (for example, for an agricultural crop, yields per unit area may be divided based on a variety of seeds and different types of fertilizers that are not completely separated. In the experiments that were analyzed, the effect of time on grain breakage rate, and also in whole peeled walnut percentage, could not be ignored. In this study, Two-way ANOVA analysis was performed on the data by SPSS software; the following results were obtained.

Discussion

The interactions between time and rotational speed and effect of them on the percentage of defective or damaged walnuts (broken and cracked). As shown in the right-hand column (sig) , in 99%, there is a significant difference between time and rotational speed with the percentage of defective walnut (broken and cracked). Also, in table 1, the effects of time and distance on the percentage of defective walnuts (broken and cracked) are shown. In 95%, there is no significant difference between time and distance with the percentage of defective walnuts (broken and cracked).

Table 1. Interactions between time and distance and effect of them on percentage of defective walnuts

Source	Type III Sum of Squares	Degree of freedom	Mean Square	F	Sig.
Corrected Model	37.920(a)	17	2.231	0.898	0.578
Intercept	63.644	1	63.644	25.618	0.000
Time	33.108	8	4.139	1.666	0.116
Rotational speed	0.281	1	0.281	0.113	0.737
Time* rotational speed	4.137	8	0.517	0.208	0.989
Error	253.405	102	2.484	—	—
Total	373.000	120	—	—	—
Corrected Total	291.325	119	—	—	—

a R Squared = 0.130 (Adjusted R Squared = -0.015)

The interactions between time and rotational speed and effect of them on the percentage of whole peeled walnuts. As shown in the right column (sig), in 99%, there is a significant difference between time and rotational speed with the percentage of whole peeled walnut (Table 2). Also, in table 3, the interactions between time and distance and effect of them on the percentage of whole peeled walnuts are shown. In 95%, there is no significant difference between time and distance with the percentage of whole peeled walnuts.

Table 2. Interactions between time and rotational speed and effect of them on percentage of whole peeled walnuts

Source	Type III Sum of Squares	Degree of freedom	Mean Square	F	Sig.
Corrected Model	5294.042(a)	17	311.414	47.330	0.000
Intercept	34796.402	1	34796.402	5288.483	0.000
Time	3988.860	8	498.607	75.780	0.000
Rotational speed	3170.975	2	1585.487	240.968	0.000
Time* rotational speed	235.531	16	33.647	5.114	0.000

Table 2. Continued

Error	671.125	102	6.580	—	—
Total	38966.000	120	—	—	—
Corrected Total	5965.167	119	—	—	—

a R Squared = .887 (Adjusted R Squared = 0.869)

Table 3. Interactions between time and distance and effect of them on percentage of whole peeled walnuts

Source	Type III Sum of Squares	Degree of freedom	Mean Square	F	Sig.
Corrected Model	2030.405(a)	17	119.436	3.096	0.000
Intercept	30525.832	1	30525.832	791.315	0.000
Time	1893.629	8	236.704	6.136	0.000
Distance	107.373	1	107.373	2.783	0.098
Time*distance	20.743	8	2.593	0.067	1.000
Error	3934.762	102	38.576	—	—
Total	38966.000	120	—	—	—
Corrected Total	5965.167	119	—	—	—

a R Squared = .340 (Adjusted R Squared = 0.230)

In Table 4 and 8, the interactions between time and distance and rotational speed and effect of them on the percentage of whole peeled walnuts and defective walnuts are shown respectively. Table 4 shows that, in 95%, there is a significant difference between time and distance with the percentage of whole peeled walnuts. Also, as shown in the right column (sig) of table 5, in 95%, there is no significant difference between time and distance with the percentage of defective walnuts.

Table 4. Interactions between time, distance and rotational speed and effect of them on percentage of whole peeled walnuts

Source	Type III Sum of Squares	Degree of freedom	Mean Square	F	Sig.
Corrected Model	5547.250(a)	35	158.493	31.857	0.000
Intercept	34796.402	1	34796.402	6993.973	0.000
Time	3988.860	8	498.607	100.219	0.000
distance	51.452	1	51.452	10.342	0.002
Rotational speed	3170.975	2	1585.487	318.678	0.000
Time*distance	12.540	8	1.568	0.315	0.958
Time* rotational speed	235.531	16	33.647	6.763	0.000
Distance* rotational speed	41.704	2	20.852	4.191	0.018
Time*distance*rotational speed	72.666	16	10.381	2.087	0.050
Error	417.917	84	4.975	——	——
Total	38966.000	120	——	——	——
Corrected Total	5965.167	119	——	——	——

a R Squared = .930 (Adjusted R Squared = 0.901)

Table 5. Interactions between time, distance and rotational speed and effect of them on percentage of damaged walnuts

Source	Type III Sum of Squares	Degree of freedom	Mean Square	F	Sig.
Corrected Model	223.575(a)	35	6.388	7.920	0.000
Intercept	160.196	1	160.196	198.620	0.000
Time	51.011	8	6.376	7.906	0.000
Distance	1.292	1	1.292	1.602	0.209
Rotational speed	115.785	2	57.892	71.778	0.000
Time*rotational speed	4.191	8	0.524	0.649	0.734
Time*rotational speed	60.809	16	8.687	10.771	0.000
Distance * rotational speed	1.272	2	0.636	0.789	0.458
Time*distance*rotational speed	4.442	16	0.635	0.787	0.600
Error	67.750	84	0.807	——	——
Total	373.000	120	——	——	——
Corrected Total	291.325	119	——	——	——

a R Squared = .767 (Adjusted R Squared = 0.671)

Conclusions

To making more coincidence between design assumption and practical conditions, the tests were arranged so as to minimize the percentage of hulled nuts and also the amount of injury rate is minimal while reasonable percentage of hulled walnuts are healthy. Therefore, six combinations of speed and distance were used and each test was performed in three replications and the percentages of whole peeled (hulled) walnuts, unpeeled walnuts and damaged walnuts were found. Because the intensity of performance was dissimilar, different durations were used in each test. Results indicate that increasing the rotational speed, increases the amount of hulled walnuts and the percentage of damaged nuts follows this behavior. If at a constant rotational speed, the distance of abrasive brushes be reduced, the amount of hulled nuts and damaged nuts are raised but the percentage of hulling is more than percentage of injury. It should be mentioned that if the distance of abrasive brushes and the rotational speed are decreased, the peeling rate increased while the damage rate decreased. According to the results the best combination obtained when the rotational speed, distance and quantity of walnuts were 368rpm, 16mm, 25 to 50, respectively. It must be noted that the duration of this combination was 60 seconds.

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