Journal of Soil Sciences and Agricultural Engineering

Journal homepage: www.jssae.mans.edu.eg
Available online at: www.jssae.journals.ekb.eg

Some Factors Affecting the Mechanical Coating of Quinoa Seeds

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ABSTRACT

The aim of this research is to study the variables influencing the mechanical coating of quinoa seeds. These factors are coating speed, temperature and time, and seed lot. The main results in this study can be summarized in the following points, the maximum quinoa-seed germinations of 90.5, 94.3, and 81.4 % by utilizing the covering unit speed of 28 rpm, covering season of 15 minutes, covering temperature of 30 °C, and covering with "Fe + Zn", "Fe + Zn + Cersan" and dirt individually. In the meantime, the base quinoa-seed germinations of 24.6, 35.4, and 22.5 % by utilizing the covering unit speed of 36 rpm, covering season of 60 minutes, covering temperature of 70 °C, and covering with similar constitutions separately, the maximum machine limit of covered quinoa seeds of 9.0 kg/h was acquired utilizing seeds-group mass of 2.5 kg and covering unit speed of 36 rpm. In the meantime, the base machine limit of covered quinoa seeds of 0.85 kg/h was acquired utilizing seeds-group mass of 0.5 kg and covering unit speed of 20 rpm, the maximum and creation costs at ideal boundaries (lot mass of 2.5 kg, covering unit speed of 28 rpm, covering temperature of 30 °C, covering season of 15 minutes, and covering with "Fe + Zn + Cersan") were 14.15 L. E./h and 4238 L.E./ton.

Keywords: Seed coating temperature, coating unit speed, coating time, quinoa seeds.

INTRODUCTION

The quinoa *(Chenopodium quinoa Willd.)* crop is one of the important crops on which many food industries are based and is characterized by a high economic return, so the Ministry of Agriculture is seeking to expand its cultivation. Also, quinoa seeds the quinoa crop has a high nutritional value. Quinoa is an energy grain rich in natural nutrients that provide the body with energy. The cultivated area of quinoa in Egypt reached about 80 feddan in 2017/2018, producing about 1- 1.5 tons per feddan (Agricultural Statistics Economic Affair Sector, the Ministry of Agriculture).

Seeds vary greatly in size, shape, and color. In many cases, seed size is tiny or irregular, making regularization and precision placement difficult. Additionally, seeds should be protected against the spread of pests that attack germination seeds or seedlings. There are two reasons for seed coating to facilitate the process of mechanical cultivation through the spacing between the plant, and the second is for the addition of insecticides. So materials may be applied within the target zone with minimal disruption to the soil ecology and environment (Taylor et al., 1998).

This method of coating can be used in the pharmaceutical and confectionery industry because its distribution is uniform over the seeds. The film-forming formulation consists of a combination of polymer, plasticizer and colorants (Halamer, 1998 and Robani, 1994), and formulations are commercially available that are ready-to-use liquids or prepared as dry powders (Ni, 1997). The mixture of the material used in coating is uniformly distributed over all the seeds(Halmer, 1998). The formed film may act as a physical barrier, which has been reported to scale back the leaching of inhibitors from seed coverings and will restrict oxygen diffusion to the embryo (Duan and Burris, 1997). A standard pelleting pan has been adapted for the appliance of film-coating polymers and drying achieved by applying forced warm air the coating pan (Taylor and Eckenrode,1993). Small-scale. The device used for coating is controlled by air velocity and temperature (Buris et al., 1994). The material used for packing is routinely done on perforated troughs and in lotes (Halmer, 1998 and Robani, 1994). The materials used coating seeds have attractive colors and an aesthetic shape of the seeds, and also the seeds have better specifications in planting, and this makes to reduce in the seeds friction. Film coating provides an ideal method for the application of chemical and/or biological seed treatments (Taylor and Harman, 1990, Taylor et al., 1994 and McGee, 1995). A major impetus for using film coating is to reduce the exposure of workers to chemicals from treated seeds. El-Habbal et al. (1995) proved that coating quinoa seeds with fertilizer containing Fe, Mn, and Zn (2:1:2 by weight) at the rate of 6.5 g/kg seeds gave significant increments in the number of spikes/plants, grain mass/plant, and both grain and straw yields/fed.

Rehm (2003) the reason for the increase in soybean yield from 0.14 to 0.79 tons / hectare regarded to seed-coated compared to uncoated seed. Yehia (2008) concluded that the optimal conditions for a packaging machine were: coating-unit speed of 28 rpm, coating temperature of 40 °C, heat exposure time 30 min, Arabic-gum temperature and concentration 50 – 110 °C and 25 – 75 %, and grain-lot mass 1 – 4 kg. Yehia et. al., (2010) found that the maximum fennel, caraway, coriander, nigella, and guar seeds germination of 98.1, 96, 98, 100 and 100 % was obtained with a coating temperature of 40 Co and coating time of 30 min. Meanwhile, the minimum fennel, caraway, coriander, nigella, and guar seeds germination of 63.38, 61.43, 66.3, 67.76, and 70.2 % were obtained with a coating temperature of 70 Co and coating time of 70 min. Abd-Al Fattah (2016) found that the highest germination percentages of 100, 98.5, 97.5 and 99.5 % were obtained at 28 rpm coating speed, 30°C coating temperature, and 15 min coating of time for onion, pepper, tomato and cotton seeds respectively.

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DOI: 10.21608/JSSAE.2021.200085

The objective of this paper is to study the factors affecting the mechanical coating of quinoa seeds such as coating temperature and duration, coating unit speed, inside coating unit on seed germination and machine productivity. In addition, the study includes the effect of quinoa-seeds coating with some trace elements of “Fe + Zn, fungicide of “ 2 % Cersan” and clay on germination percent and crop productivity.

MATERIALS AND METHODS

The coating machine

The coating machine used in this study was designed by Abd-Al Fattah et al. (2015) and Abd-Al Fattah (2016). The coating machine are shown in Figs. 1. Having a total height of 60 cm, width of 50 cm, depth of 40 cm, with total mass of 18 kg. The main coating machine parts are;

Frame made of steel sheet with a thickness of 2 mm, a height of 50 cm, width of 40 cm, and depth of 50 cm. Coating pan or unit made of the copper sheet of 3 mm, takes an elliptical shape, with diameter 35 cm, the coating-unit shaft made of steel with a diameter of 20 mm and a length of 100 mm. Two hinged links connect the hot-air dryer with coating-machine frame. The two hinged links are used to enter and exit the air dryer inside or outside the coating pan and adjust the distance between seeds and hot-air dryer head. The two hinged links are made of plastic tube with diameter of 40 mm and thickness of 3 mm. The first link which connects with the air dryer has 200 mm length. The second link which connects with seed-coating frame with 200 mm length.

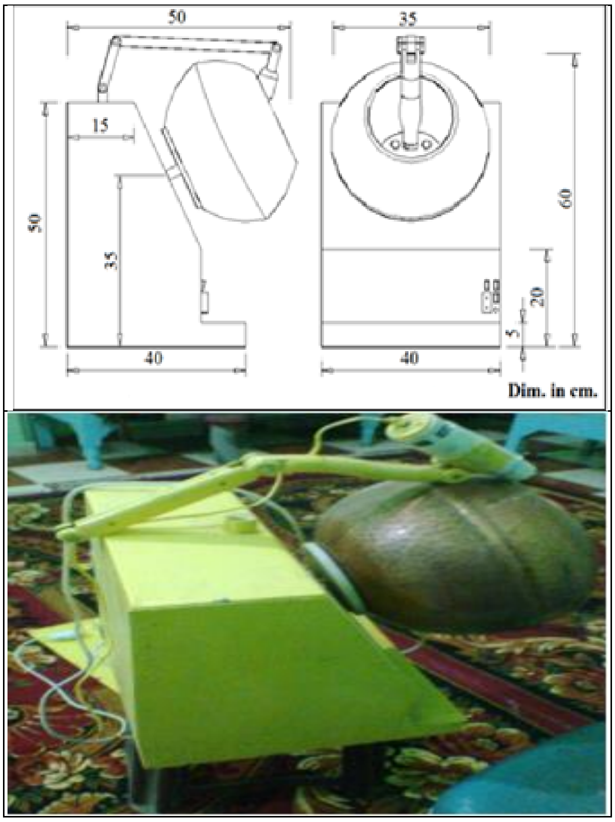

Fig. 1. Views and Photograph of a seed-coating machine Abd-Al Fattah *et al.* (2015), Abd-Al Fattah (2016).

The hot-air dryer consists of case, electric motor, fan, and heater. which attached with coating-machine frame to enter and exit it inside or outside the coating pan.

Power unit comprises of a DC motor, transformers, scaffold, switches, and electric links. DC motor details are displayed in table 1. Two transformers were utilized to acquire the voltages which gave the tried covering speeds. The primary transformer gives 6 and 12 volts. The two negative and positive edges of 6 volts are associated with a switch which gives a covering unit speed of 20 rpm. Likewise, the two negative and positive edges of 12 volts are associated with a switch which gives a covering unit speed of 36 rpm. In the meantime, the subsequent transformer gives 18 volts. The two negative and positive edges of 9 volts are associated with a switch which gives a covering unit speed of 28 rpm. Transformer determinations were displayed in table 2.
Bridges changes exchanging to coordinate current.

Table 1. Specifications of the DC motor with gear box of 25: 1 speed ratio.

Model:	**GMX -8 PVO 248.**		
Made in:	Japan.		
Voltage:	6	9	12
Speed, rpm.	20	28	36

Table 2. Specifications of used transformers.

First Transformer	**Type**	**PF 4025 K.002**	**Made in Germany**
First	Input	220 - 240 v	
	Out put	6 V - 2.6 A 12 V - 1.6 A	
	TF	130 °C	
Second Transformer	Type	PF 4025 K.002	Made in Germany
	Input	220 - 240 v	
	Out put	9 V - 2.6 A	
	TF	130 °C	

The indoor experiments were concluded on quinoa seeds with variety of Giza 138 under two coating materials (chemical and clay); the Arabic gum solution (75 % concentration was used according to Yehia, 2008).four grain lots (0.5, 1, 1.5, and 2 kg); six resting of coating times (15, 20, 30, 40, 50 and 60 minutes) and three level of coating unit rotate (20, 28, 36 rpm) under Coating temperature of 30, 40, 50, 60 and 70 °C.\

Coating steps

(1) Each synthetic powder: included "Fe and Zn" and fungicide of "2%Cersan " were blended with wheat flour powder in the proportion of 5 g/kg,
(2) The wheat flour powder of 0.5 kg was spread inside the pivoting covering container (unit) which was warmed by the hot-air dryer. The temperature of the covering skillet and seeds was constrained by the warmth control button and the distance among seeds and the hot-air dryer head.
(3) The quinoa seeds lot was spread inside the rotating coating pan.
(4) Arabic-gum solution with 75 cm^3 volume was spread on the seeds inside the coating pan.
(5) The seeds were disturbed to convey the Arabic gum.
(6) The combination of synthetic substances and wheat flour powder of around 70 g was spread straightforwardly after then, at that point. The seeds were unsettled to convey powder and add it as a layer around the seeds.
(7) The means from 4 to 6 were rehashed until completing the company (first) layer. The escort layer needs a 1: 2 blend powder seed proportion.
(8) The seeds exit from the coating pan and were spread in the air to dry.
(9) The dried coated seeds were put inside the coating pan.

(10) The steps from 4 to 6 were rehashed until completing the coat layer. The coat layer needs a 0.3: 1 wheat flour powder seed proportion.

(11) The seeds exit from the coating pan and were spread in the air to dry.

Studied factors:

- **Seed lots:** 0.5, 1, 1.5, 2 and 2.5 kg were used.
- **Coating times:** 15, 20, 30, 40, 50 and 60 minutes were used.
- **Coating-unit speeds:** 20, 28 and 36 rpm were used. The coating-unit speed was measured by counting the number of revolutions per minutes.
- **Coating temperature**: 30, 40, 50, 60 and 70 °C
- **Coating materials:** "Fe + Zn", "Fe + Zn +Cersan", and "clay".

Measurements

Physical and mechanical properties of 1000 seeds for sesame seeds such as length, width, thickness, mass, volume, projected area, bulk and real densities, friction coefficient and angles of repose were measured before and after coating according to Mohesnin, 1986.

Germination test was conducted by using 100 seeds which was planted in foam bins with 100 cells (holes), these cells was filled with sand and peat moss with ratio 1: 1, temperature range from 37.9 to 40 °C, light intensity 210 (feet-candle) and relative humidity "RH" of 85 %. The seed germinations were measured after 7 – 10 days at different tested parameters.

Seed-coating machine capacity calculated by using the following equation:

$$P_m = W / T \quad .. (1)$$

Where

P_m = Machine capacity, kg/h, W = Mass of coated seeds, kg and T = Coating time, h.

Solubility in soil was determined as the weight of the film that is dissolved after incorporating coated seeds in soil. A round film test was cut from each film, dried at 100 ± 2°C for 24 h in a lab oven, and weighed to decide the underlying dry weight. The solvency in the dirt of the diverse composite movies was estimated by consolidating covered seeds in soils with moister substance of 10, 20, 40, 60, 80, and 100 % and joined occasions of 6, 12, 18, 24, and 30 h. After that period, the excess bits of film were taken out and dried at 100 ± 2°C until steady weight (last dry weight).The percentage of the total soluble matter "TSM" of the films was calculated using the following equation:

$$\text{TSM, \%} = \frac{\text{Initial dry weight} - \text{Final dry weight}}{\text{Initial dry weight}} \times 100 \quad . (2)$$

This test for each type of film are carried out in three replicates and average reported (Gontard et al., 1994).

The crop yields were evaluated by taking 4 samples (1 m^2 area) randomly selected from each plot. The plants were collected manually and then weighed.

The power requirement of DC motor was calculated according to Kurt, 1979 and the Specific energy was calculated by using the following equation:

$$P = I \times V \quad \dots (3)$$

Where:

P = Power requirement for the seed-coating machine in W,

I = Line current strength in amperes,

V = Potential difference (Voltage) being equal to 6, 9 and 12 V,

$$\text{Specific energy, kW. h/ton} = \frac{\text{Power, kW}}{\text{Machine capacity, ton/h}} \quad (4)$$

Cost of operation was calculated according to the equation given by Awady (1978), in the following form:

$$C = p/h(1/a + i + t/2 + r) + (Ec * Ep) + m/144 \quad \dots\dots\dots (5)$$

Where: C = hourly cost, p = price of machine, h = yearly working hours, a = life expectancy of the machine, i = interest rate/year, t = taxes, r = overheads and indirect cost ratio, Ec = Electricity consumption kW.h/h, Ep = electricity price L.E/kW.h and "144" are estimated monthly working hours. Notice that all units have to be consistent to result in L.E/h.

RESULTS AND DISCUSSION

Quinoa seeds germination

Fig. 2 shows the effect of coating temperature, time, speed, and material ("Fe, Zn and Cersan" and clay) on quinoa-seed germination.

The maximum quinoa-seed germinations of 90.5, 94.3, and 81.4 % were obtained using coating with "Fe + Zn", "Fe + Zn + Cersan" and clay respectively at the coating-unit speed of 28 rpm, coating time of 15 minutes and coating temperature of 30 °C. Meanwhile, the minimum quinoa-seed germinations of 24.6, 35.4 and 22.5 % were obtained using coating with "Fe + Zn", "Fe + Zn + Cersan" and clay respectively at the coating-unit speed of 36 rpm, coating time of 60 minutes and coating temperature of 70 °C.The germination of quinoa seeds without coating was 76.1.%

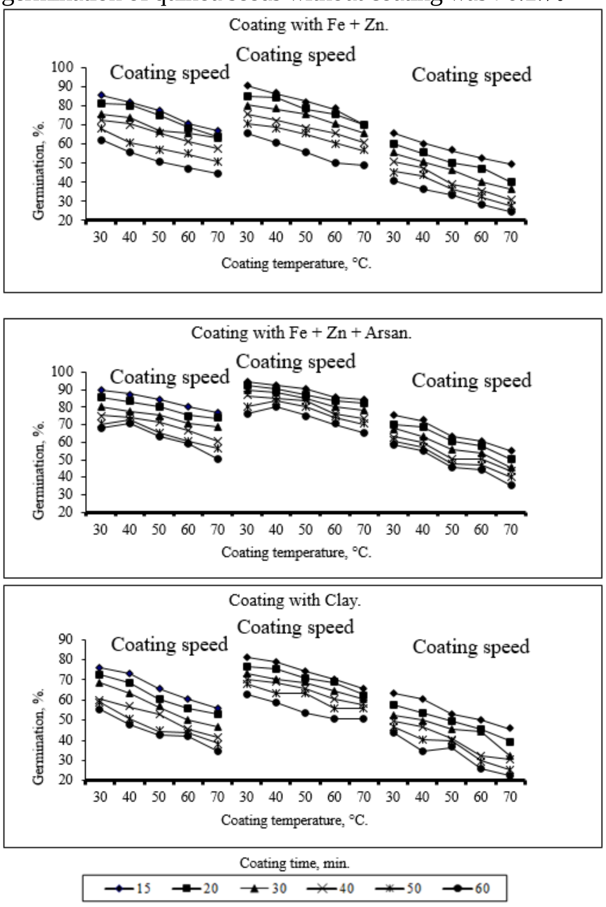

Fig. 2. Effect of coating temperature and time, by "Fe + Zn", "Fe + Zn + Cersan" and clay on quinoa-seeds germination.

By increasing coating speed from 20 to 28 rpm the quinoa-seed germinations increased by 5.5, 4.5, and 6.7 % for coating with "Fe + Zn", "Fe + Zn + Cersan" and clay respectively. Meanwhile, by increasing coating speed from 28 to 36 rpm, the quinoa-seed germinations decreased by 27.3, 20.0, and 22.3 % for coating with "Fe + Zn", "Fe + Zn + Cersan" and clay respectively.

By increasing coating time from 15 to 60 minutes the quinoa-seed germinations decreased by 34.3, 22.8, and 32.3 % for coating with "Fe + Zn", "Fe + Zn + Cersan" and clay respectively .

By increasing coating temperature from 30 to 70 °C the quinoa-seed germination decreased by 34.9, 45.1, and 32.7 % for coating with "Fe + Zn", "Fe + Zn + Cersan" and clay respectively.

Seed germinations increase by coating with "Fe + Zn + Cersan" may be due to feeding seed-embryo by "Fe + Zn" and fungicide protection by "Cersan" through the seed-germination period. Increasing germination using seed heat-treatment at 30 °C may be due to activating seed embryos and accelerating seed germination. Seed witting by Arabic gum and heating by hot air through the seed-coating process is like "the vernalization" phenomenon which encourages germination and plants flowering. Decreasing seed-germination at a coating-temperature range of 50 - 70 °C and coating time 60 - 65 minutes maybe death to die of some embryo seeds.

It is noticed from practical experiments that the optimum Arabic-gum solution temperature ranged between 50 to 110 C° and concentration ranged between 25 to 76 % which gave the optimum quinoa-seed germination of 90.5 % coating efficiency of 94.3 %.

Effect of coating-unit speed and seed-lot mass on Coated-seeds machine capacity

Fig. 3 shows the effect of coating-unit speed and seed-lot mass on the machine capacity. The machine capacity of coated quinoa seeds increased about 12.3 % by increasing coating-unit speed from 28 to 36 rpm. Meanwhile, the machine capacity of coated quinoa seeds increased about 77.6 % by increasing seeds-lot mass from 0.5 to 2.5 kg. The maximum machine capacity of coated quinoa seeds of 9.0 kg/h was obtained using seeds-lot mass of 2.5 kg and coating-unit speed of 36 rpm. Meanwhile, the minimum machine capacity of coated quinoa seeds of 0.85 kg/h was obtained using seeds-lot mass of 0.5 kg and coating-unit speed of 20 rpm.

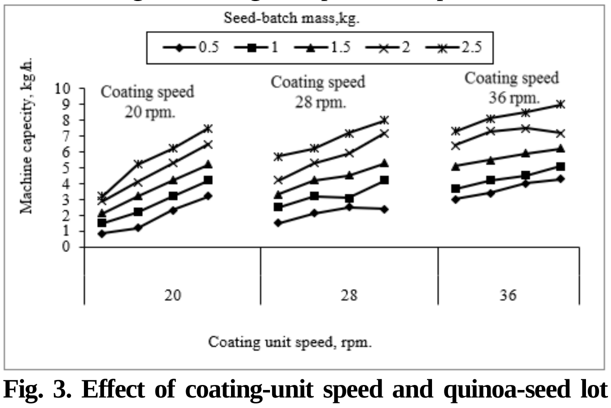

Fig. 3. Effect of coating-unit speed and quinoa-seed lot mass on coated-seeds machine capacity.

Coating-film solubility in soil

Fig. 4 shows the effect of soil moisture content, soluble time on the solubility of coating films for quinoa seeds.

The maximum solubility of coated films for quinoa-seeds of 100 % was obtained using a soluble time of 72 h and soil moisture content of 100 %. Meanwhile, the minimum solubility of coated films for quinoa-seeds of 5.5 % was obtained using soluble time 12 h and soil moisture content of 10 %.

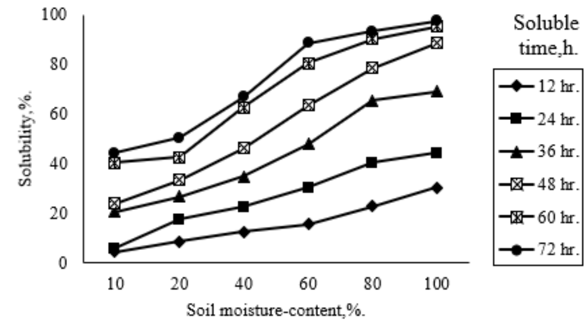

Fig. 4. Effect of soil moisture-content, soluble time on coating-film solubility of quinoa-seeds.

Power requirement and specific energy

Figs. 5 and 6 show the effect of coating-unit time and quinoa-seed lot mass on power requirement and specific energy. The maximum power and specific energy of 340.7 W and 0.147 kW.h/ton was obtained at coating-unit speed of 36 rpm and seed lot-mass of 0.5 kg. Meanwhile, the minimum power and specific energy of 125.6 W and 0.0179 kW.h/ton was obtained at coating-unit speed of 28 rpm seed lot-mass of 2.5 kg.

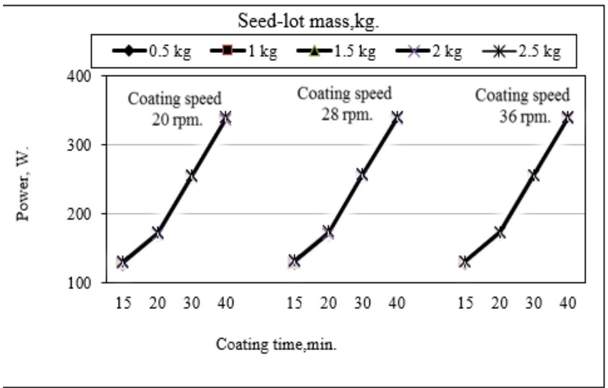

Fig. 5. Effect of coating-unit time and quinoa-seed lot mass on power requirement at speed and quinoa-seed batch mass.

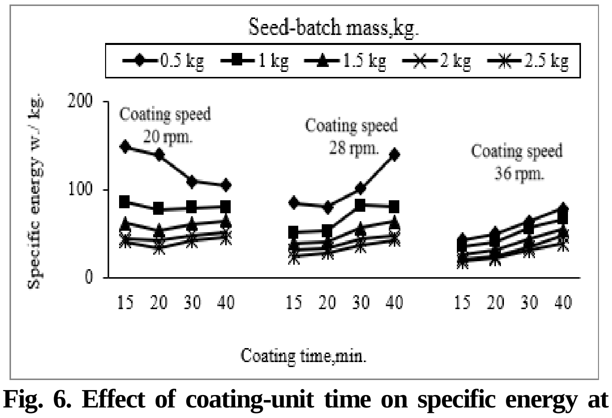

Fig. 6. Effect of coating-unit time on specific energy at speed and quinoa-seed batch mass.

Physical and mechanical properties of quinoa seeds

Tables 3 and 4 show physical and mechanical properties of quinoa-seeds before and after coating at optimum parameters (lot mass of 2.5 kg, coating-unit speed of 28 rpm, coating temperature of 30 °C, coating time of 15 minutes, and coating with "Fe + Zn + Cersan."). The averages mass of 1000 seeds before and after coating are 25 and 46.3 g. Averages of seed length, width, and thickness before coating were "3.3, 3.5, and 2.2 mm" and after coating were 4.75, 3.6, and 2.51 respectively. The average bulk and real densities before coating were 380 and 402.5 kg/m3 and after the coating is 422.5 and 450 kg/m3 respectively. Averages of quinoa seed volume before and after coating were 12.7 and 43.7 mm^3. Averages of the projected area of quinoa seeds before and after coating were 11.6 and 17.4 mm^2 respectively.

Table 4 shows that maximum friction-angle with glass, wood, stainless steel, copper, galv. iron-sheet and iron sheet before coating are 16.5, 22.5, 14.3, 26.4,14.6 and 17.2 degree respectively and after coating are 18.9, 24.3, 16.9, 27.6, 17.6 and 20.6 degree. Averages of angle of repose before and after coating are 14.05 and 20.4 respectively. Meanwhile, the maximum repose-angles before and after coating are 16.5 and 20.1 degree respectively.

The maximum solubility of coated films for quinoa-seeds of 100 % was obtained using a soluble time of 72 h and soil moisture content of 100 %. Meanwhile, the minimum solubility of coated films for quinoa-seeds of 5.5 % was obtained using soluble time 12 h and soil moisture content of 10 %.

Table 3. Physical properties of quinoa-seeds before and after coating at optimum parameters.

Properties	Before coating				After coating			
	Max.	Min.	Av.	C. V.	Max.	Min.	Av.	C. V.
The mass of 1000 seed	24.5	25.6	25.0	0.38	50.7	42	46.3	6.15
Real density, kg/ m³	410	395	402.5	10.6	475	425	450	35.3
Bulk density, kg/ m³	385	375	380	7.7	445	400	422.5	31.8
Dimensions:								
Length, mm.	3.35	3.25	3.3	0.07	4.95	4.55	4.75	0.28
Width, mm	3.64	3.45	3.5	0.13	3.90	3.43	3.6	0.33
Thickness, mm	2.25	2.15	2.2	0.07	2.60	2.42	2.51	0.12
Volume, mm^3	27.4	24.1	12.7	2.3	50.19	37.7	43.7	8.8
Projected area, mm^2	12.1	11.2	11.6	0.6	19.30	15.60	17.4	2.6

Max: maximum, Min.: minimum, Av.: average and C. V.: coefficient of variation.

Table 4. Mechanical properties of quinoa-seeds before and after coating at optimum parameters.

Properties	Before coating			After coating		
	Max.	Min.	Av.	Max.	Min.	Av.
Angle of repose	16.5	11.6	14.05	20.1	18.1	20.4
Friction angle:						
- Glass	16.5	13.3	14.9	18.9	15.4	17.15
- Wood	22.5	16.3	19.4	24.3	21.6	22.95
- Stainless steel	14.3	12.6	13.45	16.9	15.8	16.35
- Copper	26.4	21.5	23.95	27.6	23.7	26.65
- Galv. iron-sheet	14.6	11.5	13.05	17.6	13.9	15.75
- Iron sheet	17.2	13.5	15.35	20.6	15.9	18.25

Max: maximum, Min.: minimum, Av.: average .and Galv.: Galvanized.

Cost of a seed coating machine

The operation and production costs of using the designed a seed coating-machine was calculated according to the equation given by Awady (1978).

The operation and production costs at optimum parameters (lot mass of 2.5 kg, coating-unit speed of 28 rpm, coating temperature of 30 0C, coating time of 15 minutes and coating with "Fe + Zn + Cersan") were 14.15 L. E./h and 4238 L.E./ton. The production cost of quinoa fruits by using coated seeds with "Fe + Zn + Cersan was 4.23 L. E./kg. Meanwhile, the production cost of quinoa fruits by using the traditional seedlings was about 6.0 L. E./kg.

CONCLUSION

The ideal states of the coating machine were: covering unit speed of 28 rpm, covering temperature of 30 °C, covering time 15 min, Arabic-gum temperature and focus 50 – 70 °C and 25 – 75 %, covering with "Fe + Zn + Cersan" and seed-lot mass 2.5 kg. The outcomes got at ideal states of quinoa were: see of 94.3 %, covering machine limit = 8.5 kg/h, explicit energy = 0.147 kW.h/ton seeds covered, and expenses of 14.15 L. E./h and 4238 L.E./ton.

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بعض العوامل المؤثرة على التغليف الميكانيكي لبذور الكينوا

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يهدف هذا البحث إلى دراسة العوامل المؤثرة على التغليف الميكانيكي لبذور الكينوا. وكانت عوامل الدراسة كالتالي: ثلاث سرعات لغرفة التغليف (20، 28، 36 لفة/د)، خمس كميات وجبة (0.5، 1، 1.5، 2، 2.5 كج)، خمس درجات حرارة "30، 40، 50، 60، 70"، ست أزمنة تغليف "15، 20، 30، 40، 50، 60 دقيقة"، تغليف البذور بمواد "الحديد +الزنك"، "حديد + زنك + سرسان"، طين، دقيق. وكانت أهم النتائج المتحصل عليها كالتالي: (1) نسبة الإنبات: وجد أن أعلى نسبة إنبات لحبوب الكينوا 94.3 % بتغليف بالهواء الساخن بحديد وزنك و سرسان "2 %" عند استخدام درجة حرارة تغليف 30 ^{0}م، زمن تغليف 15 دقيقة وسرعة 28 لفة / دقيقة. بينما وجد أن أقل نسبة إنبات لحبوب الكينوا 22.5% بدون تغليف عند استخدام درجة حرارة تغليف 70 ^{0}م، زمن تغليف 60 دقيقة وسرعة 36 لفة/دقيقة.(2) معدل أداء آلة التغليف: تم الحصول على أعلى معدل أداء لآلة التغليف 9.0كج/س عند استخدام الآلة على سرعة تغليف 36 لفة/د، وكمية وجبة الحبوب 2.5 كج. بينما تم الحصول على أقل معدل أداء لآلة التغليف 0.85 كج/س عند استخدام الآلة على سرعة تغليف 20 لفة/د، وكمية وجبة الحبوب 0.5 كج. (3) الإنتاجية: تم الحصول على أعلى إنتاجية حبوب الكينوا (1.5 كج/م^{2}) عند استخدام بذور الكينوا المغلفة بالحديد + الزنك + سرسان فى الزراعة، كما تم الحصول على أقل إنتاجية (0.4 كج/م^{2}) عند استخدام الحبوب غير المغلفة(4) معدل الإذابة: وجد ان أعلى معدل إذابة كان 100 % عند زمن إذابة 30 ساعة ونسبة رطوبة 100 %، بينما كان اقل معدل إذابة كان 5.5 % على زمن 6 ونسبة رطوبة 10 %.(5) تكاليف تشغيل الآلة: كانت التكاليف المتحصل عليها عند أنسب ظروف (سرعة 28 لفة/د، كمية وجبة 2.5 كج، درجة حرارة 30 م^{0}، زمن تغليف 15 دقيقة، مادة تغليف "حديد + زنك + أرسان" هي 14.15 جنيه/ساعة أو 4238 جنيه/طن بذور مغلفة.