Determination of threshing and separation unit performance of rosemary (*Rosmarinus officinalis*) plants

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Abstract: Rosemary (*Rosmarinus officinalis* L.) is an important perennial medicinal and aromatic plant belonging to the *Lamiaceae* family. Rosemary is widely produced in Turkey for its oil which can be extracted from the plants when flowers are in buds. In Turkey, a significant amount of domestic and foreign trade of rosemary is conducted. In 2018-2020, 2088 t of rosemary plants were imported, while in the same years 2077 t were exported. In this study, the performance indexes of a threshing and separating unit designed according to the physicomechanical properties of the rosemary were determined. The operating parameters of the machine were determined at three different moisture contents and adjusted according to the harvest moisture values. The threshing efficiency, work efficiency, power requirement, and specific energy consumption values of the threshing unit were determined, while separating efficiency, work efficiency and specific power consumption of separating unit of the developed system were determined. According to the study results, the threshing efficiency of the rosemary plant varied between 44.00% and 96.97%. Work efficiency of the thresher varied between 1.18 and 15.34 kg/h. Power requirements and specific energy consumption of the threshing unit were obtained as 0.19-1.05 kW and 0.02-0.37 kW·h/h, respectively. On the other hand, the separating efficiency of the separating unit for the rosemary plant varied between 44.27% and 85.24%. Maximum and minimum values of work efficiency were found as 0.75 kg/h and 5.52 kg/h. Specific power consumption of the unit ranged from 3.95 to 39.95 kW/kg.

Keywords: rosemary, mechanization, threshing, separating, design, Turkey
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1 Introduction

Rosemary is an aromatic perennial shrub native to the coasts of the Mediterranean Sea. The plant has narrow, thin, glossy, scented leaves. The plant stem is woody, resinous, and has a bitter taste[1] Rosemary (*Rosmarinus officinalis* L.) is currently a widely used aromatic and medicinal plant. Many countries meet the needs of rosemary by harvesting from natural plants. In Turkey, rosemary collected from the natural flora of Mersin and Adana is presented to markets[2]. The rosemary is a strong aromatic plant using pharmaceutical industry due to its antioxidant and antimicrobial properties[3,4]. Rosemary has been used extensively as a source of strong antioxidant, antibacterial, antimutagenic properties and natural bioactive compounds. The antioxidant activity of rosemary is used in a wide array of applications, including food preservation. The plant leaves are also used as a condiment in food or flavoring of food products[5,6]. Although the use of fresh rosemary is not very common, dry rosemary forms are widely used in the food industry[7].

Different properties of the rosemary increase its importance, and essential oils, plant extracts and some isolated components are subjected to some pharmacological research. Among the plants reported to have antioxidative activity rosemary is the most widely used and commercialized[8-10].

Rosemary plant, "rosemary oil" is grown for the aromatic oil and obtained by distillation of the plant leaves and flowers[11]. Rosemary (*Rosmarinus officinalis* L.) is a sempervirent, branched shrub with stiff stems, whitish-blue flowers and small dark green leaves at the back (Figure 1)[12]. It grows wildly along the northern and southern coasts of the Mediterranean, as well as in the Himalayan sub-regions[11].

It can be exposed to various types of mechanical loads during harvest and post-harvest operations such as transportation, packaging, storage, and this causes significant damage and losses[13,14]. In particular, crop damage can occur during the harvest, transport and threshing processes of the rosemary plant[15]. Bai et al.[16] conducted a study to determine the optimal settings and performance tests of the crop sections of the sugarcane chopper harvester. Du et al.[17] designed a hand-held oil-tea fruit harvesting machine that can be operated by workers in hilly areas and carried out field experiments using the developed comb-brush harvesting machine. Huang et al.[18] has carried out the research and development of a small hemp harvester based on the absorption of domestic and foreign advanced technology of hemp harvester and conducted the field experiment of the machine. Some problems are confronted in the harvesting and post-harvesting stages of cultivation. These problems occur as the product is not threshing completely at high moisture contents or the product is poured quickly at very low moisture contents[19,20]. In order to reduce these problems, it is necessary to machine the threshing and separating works and to determine the optimum working conditions of the machine for the rosemary plant.

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Figure 1 Rosemary plants

When the studies on this subject are researched, the threshing and separation of rosemary are usually made by human power. No machine has been found that performs threshing and separating processes at the same time. For this reason, the innovative aspect of this work is quite high. In this study, the working parameters and system performance of the threshing and separating machine for rosemary were determined.

2 Materials and methods

As a result of the preliminary tests, the working intervals of the machine for the rosemary plant were measured. Factor and level values were determined according to these values and a trial plan was created.

The experiments were performed at three different moisture contents (8.9%, 12.0%, and 14.8%), three different drum speeds (100 r/min, 250 r/min, and 400 r/min), three different drums clearances (14, 15, and 16 mm) and three different feed rates (190 kg/h, 380 kg/h, and 570 kg/h) for the threshing efficiency. The system was conducted at three different sieve types (2 mm round hole, 6 mm round hole and 4-20 oblong sieve), three different feedings (190 kg/h, 380 kg/h, and 570 kg/h), three different sieve oscillating frequencies (35 mm, 40 mm, and 45 mm) and three different sieve slopes (14.0%, 15.8%, and 17.6%) for the separating efficiency. Each experiment was carried out with three replications. The experiment design was randomized blocks.

The performance tests of the machine, built for the rosemary were carried out at the harvest laboratory in Isparta Applied Science University, Turkey. The machine manufacturing picture was shown in Figure 2. The rosemary plants used in this study were harvested from the experimental field and dried after harvesting to the desired moisture content[13].

Moisture content is an important factor in determining threshing efficiency[18]. As a result of preliminary tests, the moisture range of the plant was determined.

The experiments conducted for threshing performance were carried out at three different moisture contents as 8.9%, 12% and 14.8% dry basis (d.b).

Moisture content is not an effective factor for separation experiments, unlike threshing. Fixed moisture content can be chosen[21]. For this reason, the moisture content of the materials was chosen as 12% in separation performance experiments. The rosemary plant, the drying time of which was determined in preliminary tests for the desired moisture value, was dried with a mechanical dryer available in the faculty laboratory. The moisture content of the rosemary plant has reached the desired level in 4 h.

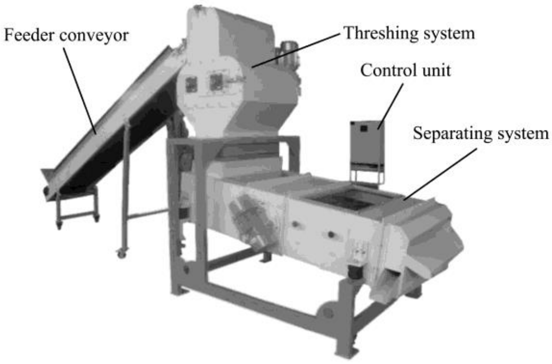


Figure 2 Rosemary threshing and separation machine

2.1 Threshing unit

Rasp-type drums are used more particularly in combine harvesters thanks to the crushing and scrubbing effects. The beaters need to be separate leaves from the stalk. Therefore, a rasp bar type of drum has been chosen for the threshing system. Eight sheet bars (35 mm×10 mm) were attached to the drum and covered with hard rubber. There are two drums with 770 mm in length and 136 mm in diameter in the threshing units. Two beaters can rotate in the same or opposite directions. The product entering the threshing unit from the conveyor is dropped the separating unit pass through the drums. The torque meter mounted to the motor shaft is calculated as the torque value and the power consumed by the threshing unit (Figure 3).

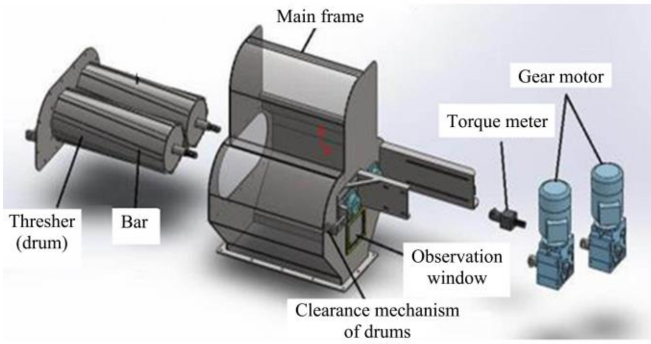


Figure 3 Rosemary threshing unit

In the course of determining threshing unit performance threshing efficiency, seed damage, unbroken capsule percentage, specific energy consumption and power requirement were used[22].

The amount of the product to feed the threshing unit in each experiment was specified as 190 kg/h, 380 kg/h, 570 kg/h. The feeding unit speed was 0.26 m/s. The drum speeds of threshing units were determined as 100 r/min, 250 r/min, and 400 r/min (1.48 m/s, 3.69 m/s, and 5.55 m/s). The working properties of the rosemary threshing unit were shown in Table 1. These operating parameters were determined according to the capacity of the machine and preliminary trials.

Table 1 Working properties of the rosemary threshing unit

	Threshing drum speed/r·min^{-1}; m·s^{-1}		Drums clearance/mm
Drum 1	Experiment 1	100; 1.48	14
	Experiment 2	250; 3.69	15
	Experiment 3	400; 5.55	16
Drum 2		35; 0.45	

2.2 Separating unit

The separating unit of the system consists of chassis, mainframe, vibrating sieves, slope adjusting mechanism and material outlet unit (Figure 4). Sieves and eccentrics were used in parallel with developing technologies in the separation system. The duration of the material on the sieve, sieve type, material amount and sieve slope are important parameters for separation efficiency[23].

For the separating, to the rosemary plant, three different sieves as 6 mm round hole, 2 mm round hole and 4-20 oblong sieves chosen in the preliminary test were used in the experiments. Feeding unit speed was determined as 0.26 m/s. Separating efficiency, work efficiency and specific power consumption of separating unit developed were determined.

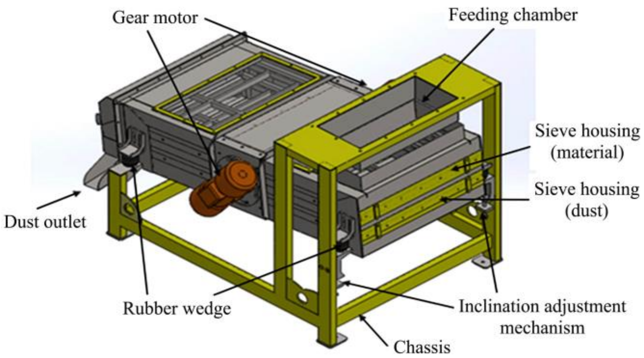


Figure 4 Rosemary separating unit

The amount of the product for feeding the separating unit was the same with the threshing experiments as 190 kg/h, 380 kg/h, 570 kg/h. The sieve oscillating frequencies of the unit were chosen as 35 Hz, 40 Hz, and 45 Hz for the experiments. The working properties of the rosemary-separating unit were shown in Table 2. These operating parameters were determined according to the capacity of the machine and preliminary trials.

Table 2 Working properties of the rosemary separating unit

Serial number	Sieve oscillating frequency/Hz	Sieve inclination/%
Experiment 1	35	14.0
Experiment 2	40	15.8
Experiment 3	45	17.6

The following equations were used to calculate the threshing efficiency (TE) and work efficiency (WE) of the machine[21].

$$TE = \frac{P_t}{P_t + P_u} \tag{1}$$

where, TE is the threshing efficiency, %; P_t is the threshed product, kg; P_u is the unthreshed product (leaves in straws), kg.

The following equation is used in the calculation of the separating efficiency of the machine.

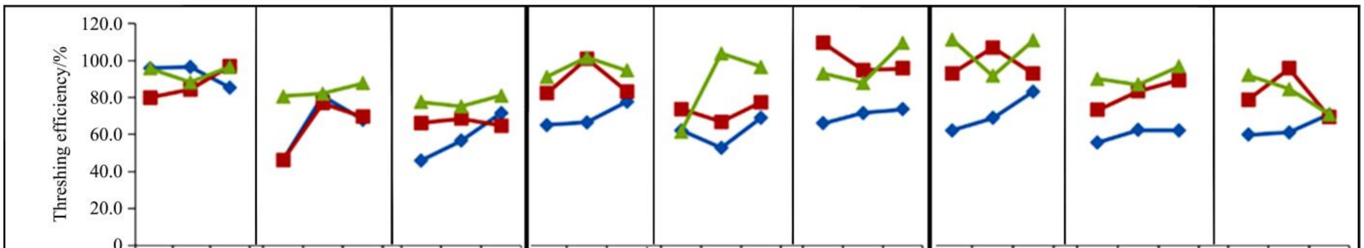
$$SE = \frac{P_s}{P_s + P_u} \tag{2}$$

where, SE is the separating efficiency, %; P_s is the separated product, kg; P_u is the unseparated product (leaves in straws), kg.

3 Results and discussion

3.1 Threshing unit performance

The efficiency values of the threshing unit varied between 44.03% and 96.97%. The effects of drums clearance, feed rate and drum speed on the threshing efficiency were given in Figure 5. As a result of the experiment carried out depending on the Lavandin's moisture content, drum distance, feed rate and drum speed of the machine threshing efficiency values ranged from 45.69% to 95.56%[21]. Depending on the moisture content of the sage, drums distance, feeding rate and drum speed of the machine, the threshing efficiency values of the system varied between 48.92% and 94.58% d.b.[25]



8.9% moisture content (d.b.)

	14 mm 190	14 mm 380	14 mm 570	15 mm 190	15 mm 380	15 mm 570	16 mm 190	16 mm 380	16 mm 570
100 r·min⁻¹	95.7	96.3	85.2	46.4	80.8	68.0	45.9	56.6	71.5
250 r·min⁻¹	79.9	84.2	96.9	46.4	76.9	69.6	66.1	68.5	64.7
400 r·min⁻¹	95.6	88.3	96.6	80.7	82.2	87.7	77.5	75.0	81.1

12% moisture content (d.b.)

	14 mm 190	14 mm 380	14 mm 570	15 mm 190	15 mm 380	15 mm 570	16 mm 190	16 mm 380	16 mm 570
100 r·min⁻¹	54.3	55.4	64.7	51.7	44.0	57.4	55.0	59.5	61.2
250 r·min⁻¹	68.5	84.1	69.2	61.4	55.6	64.3	91.2	78.8	79.7
400 r·min⁻¹	75.8	84.5	78.7	51.3	86.4	80.3	77.5	73.2	91.1

14.8% moisture content (d.b.)

	14 mm 190	14 mm 380	14 mm 570	15 mm 190	15 mm 380	15 mm 570	16 mm 190	16 mm 380	16 mm 570
100 r·min⁻¹	51.9	57.4	69.2	46.4	52.0	51.7	49.9	50.9	59.0
250 r·min⁻¹	77.5	89.3	77.4	61.0	69.4	74.4	65.7	79.7	57.7
400 r·min⁻¹	92.8	76.4	92.3	75.1	72.5	80.6	76.6	70.4	58.9

Note: The value in each cell indicates average threshing efficiency values according to the drums distance, feed rate and drum speed.

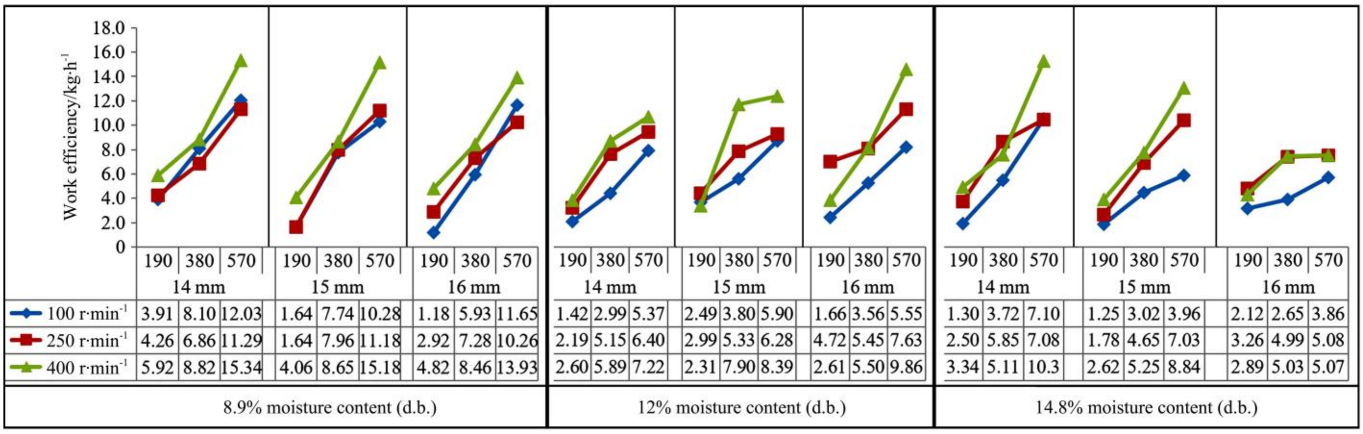
Figure 5 Threshing efficiency values of rosemary thresher

According to the result of the performance experiments of the machine, the threshing efficiency was decreased while the moisture content was increased. The interactions of drums clearance ×feed rate ×drum speed on the efficiency of the threshing unit at 8.9%, 12% and 14.8% d.b. moisture contents were found statistically significant (p<0.05). The highest value of the efficiency was calculated as 96.97% at 8.90% d.b. moisture content, 14 mm drums clearance, 250 r/min drum speed and 570 kg/h feed rate. The lowest efficiency of the machine was calculated as 44.03% d.b at 12% d.b. moisture content, 15 mm drums clearance, 100 r/min drum speed and 380 kg/h feed rate. The effects of drums clearance ×feeding rate ×drum speed on the work efficiency were shown in Figure 6.

The work efficiency was decreased with increasing moisture content. The interactions of drums clearance ×feed rate ×drum speed on the work efficiency at different moisture contents were found statistically significant (p<0.05). The highest efficiency values were reached for rosemary with the thresher operating parameters adjusted as 14 mm drums clearance, 400 r/min drum speed and 570 kg/h feed rate. The highest and lowest work efficiency values were determined as 1.18 kg/h and 15.34 kg/h at 14.3% moisture content. In the study conducted by Bai et al.[16], the threshing efficiency value was found between 0.67 and 12.27 kg/h for lavandin. The work efficiency values ranged from 1.43 to 11.87 kg/h for sage plants[25].

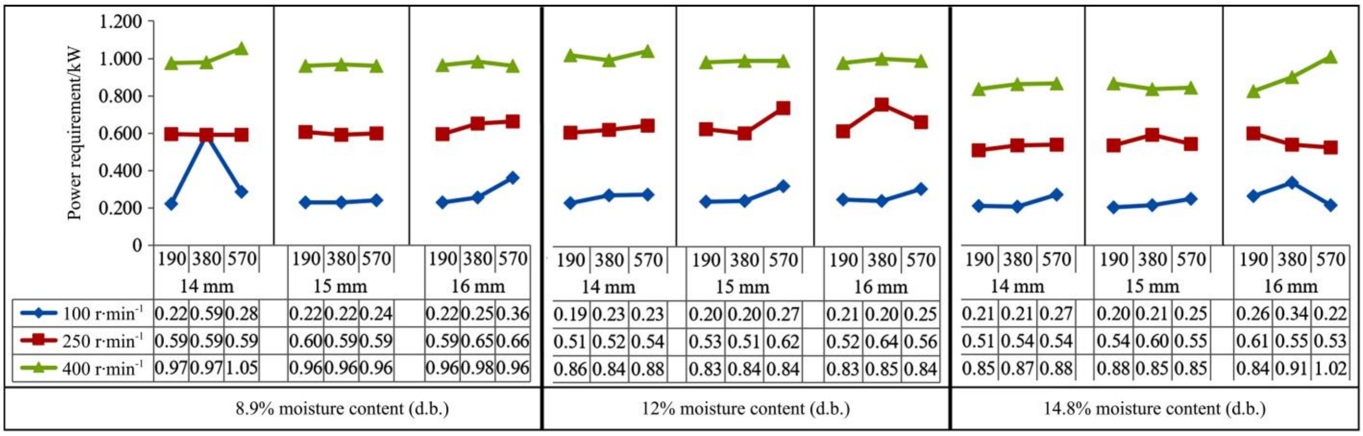
The power requirement of the threshing unit of the machine needs to be calculated for system performance. The effects of drums clearance×feed rate×drum speed on the power requirement were shown in Figure 7.

The power requirement values of the threshing unit for the rosemary plant varied between 0.19 and 1.05 kW. The power requirement values of the lavandin threshing unit, depending on the moisture content, drums distance, feeding rate and drum speed of the threshing unit, varied between 0.200 and 1.081 kW[24]. The triple interaction of drums clearance ×feed rate × drum speed on the power requirement was found statistically significant (p<0.05). The power requirement of the thresher was decreased up to 12% moisture content. The values increased by increasing the moisture content of the plants to 14.8%. While the highest values were obtained at the same drums clearance, 400 r/min drum speed and 570 kg/h feed rate, the lowest power requirement values were determined with the parameters of 14 mm drums clearance, 100 r/min drum speed and 190 kg/h feed rate.



Note: The value in each cell indicates average work efficiency values according to the drums distance, feed rate and drum speed.

Figure 6 Work efficiency values of rosemary threshing unit



Note: The values in each cell indicate average power requirement values according to the drums distance, feed rate and drum speed.

Figure 7 Power requirement values of rosemary threshing unit

According to the results, the specific energy consumption of the threshing machine was increased with increasing moisture content. The specific energy consumption values of the threshing unit were found between 0.02 and 0.37 kW·h/kg (Figure 8), while they were ranged from 0.03 to 0.59 kW·h/kg for lavandin plant[24]. On the other hand, values of the threshing unit performed for the sage plant were found between 0.028 and 0.534 kW·h/kg[25].

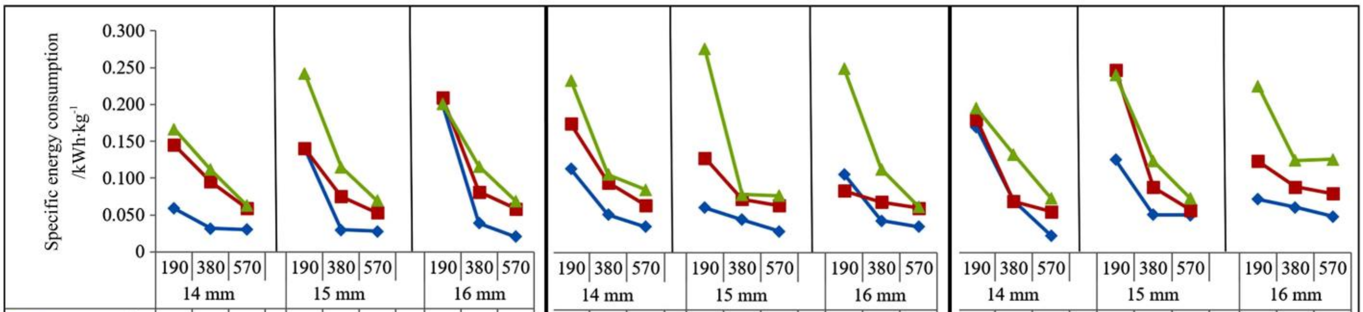
The interactions of drums clearance ×feed rate ×drum speed on the specific energy consumption were found statistically significant (p<0.05). The highest values were observed at 12% moisture content. The lowest specific energy consumption of the machine was obtained at 8.9% moisture content. While specific energy consumption of the unit was lowest at 16 mm drums clearance, 570 kg/h feed rate and 100 r/min drum speed, it was highest at 15 mm drums clearance, 190 kg/h feed rate and 400 r/min drum speed.

3.2 Separating unit performance

The efficiency values of the separating unit of the system were ranged from 44.27% to 99.00%. In the study conducted by Yilmaz et al.[26], the separating efficiency was found between 41.44% and 97.49% for the sage plant. According to this study results the effect of sieve oscillating frequency, feeding rate and sieve inclination on the separating efficiency with different sieve types are shown in Figure 9.

As a result of the experiments the highest separating efficiency value was found at 15.8% sieve slope, 380 kg/h feed rate and 45 Hz of sieve oscillating frequency with 4-20 oblong sieve type. The lowest separation efficiency was observed in experiments with a 2.0 mm hole sieve with a sieve inclination of 14.0%, a feed rate of 380 kg/h and a sieve rate of 40 Hz. The triple interaction of sieve oscillating frequency, feed rate and sieve slope on separation efficiency with three different sieve types was statistically significant (p<0.05).

According to the results of the study carried out for rosemary plants, the interaction of sieve oscillating frequency, feed rate and sieve slope with the work efficiency values are shown in Figure 10.



8.9% moisture content (d.b.)

	14 mm 190	14 mm 380	14 mm 570	15 mm 190	15 mm 380	15 mm 570	16 mm 190	16 mm 380	16 mm 570
100 r·min^{-1}	0.05	0.03	0.03	0.14	0.03	0.02	0.20	0.03	0.02
250 r·min^{-1}	0.14	0.09	0.05	0.14	0.07	0.05	0.21	0.08	0.05
400 r·min^{-1}	0.16	0.11	0.06	0.24	0.11	0.07	0.20	0.11	0.06

12% moisture content (d.b.)

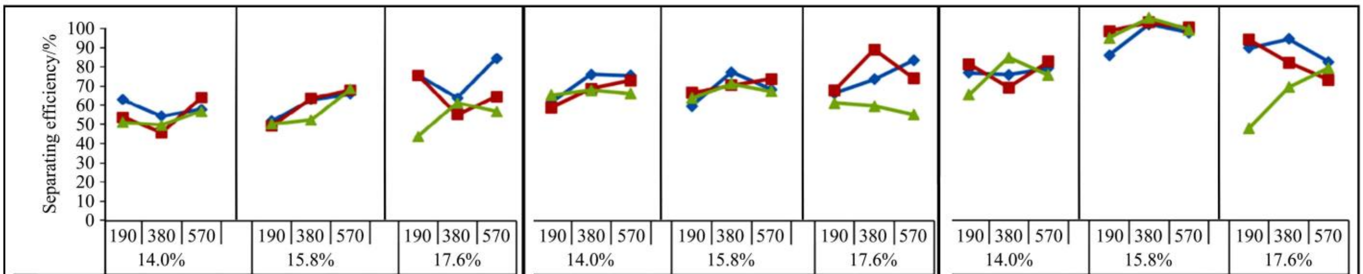
	14 mm 190	14 mm 380	14 mm 570	15 mm 190	15 mm 380	15 mm 570	16 mm 190	16 mm 380	16 mm 570
100 r·min^{-1}	0.15	0.07	0.04	0.08	0.06	0.04	0.14	0.06	0.04
250 r·min^{-1}	0.23	0.13	0.08	0.17	0.09	0.08	0.11	0.09	0.08
400 r·min^{-1}	0.31	0.14	0.11	0.37	0.10	0.10	0.34	0.15	0.08

14.8% moisture content (d.b.)

	14 mm 190	14 mm 380	14 mm 570	15 mm 190	15 mm 380	15 mm 570	16 mm 190	16 mm 380	16 mm 570
100 r·min^{-1}	0.23	0.09	0.03	0.17	0.07	0.06	0.09	0.08	0.06
250 r·min^{-1}	0.24	0.09	0.07	0.33	0.12	0.07	0.16	0.12	0.10
400 r·min^{-1}	0.26	0.18	0.10	0.32	0.16	0.10	0.30	0.16	0.17

Note: The value in each cell indicates average specific energy consumption values according to the drums distance, feed rate and drum speed.

Figure 8 Specific energy consumption values of rosemary threshing unit



2 mm round hole sieve

	14.0% 190	14.0% 380	14.0% 570	15.8% 190	15.8% 380	15.8% 570	17.6% 190	17.6% 380	17.6% 570
35 Hz	63.4	54.9	58.3	52.2	63.4	66.4	76.3	64.4	85.2
40 Hz	54.2	46.0	64.6	49.6	64.1	68.4	76.3	55.5	65.1
45 Hz	51.5	50.1	57.2	50.8	52.8	69.0	44.2	61.7	57.3

6 mm round hole sieve

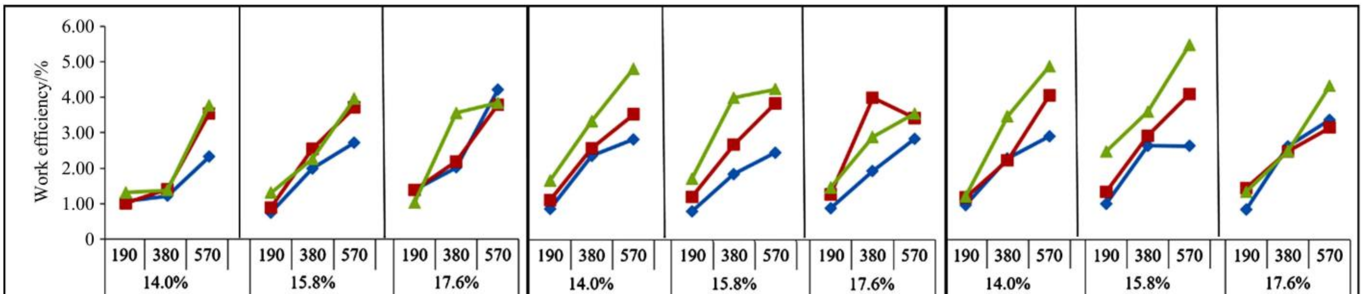
	14.0% 190	14.0% 380	14.0% 570	15.8% 190	15.8% 380	15.8% 570	17.6% 190	17.6% 380	17.6% 570
35 Hz	59.02	72.41	71.75	57.32	73.45	65.20	63.45	70.00	79.24
40 Hz	56.53	65.62	69.53	63.57	67.11	70.26	64.78	84.20	70.42
45 Hz	62.51	64.82	63.13	60.99	67.80	64.30	58.77	57.28	53.24

4-20 mm oblong sieve

	14.0% 190	14.0% 380	14.0% 570	15.8% 190	15.8% 380	15.8% 570	17.6% 190	17.6% 380	17.6% 570
35 Hz	72.82	71.95	75.01	81.39	96.00	92.00	84.74	89.00	78.07
40 Hz	77.03	65.88	78.27	92.70	97.00	94.36	88.67	77.77	69.38
45 Hz	62.43	80.20	71.75	89.49	99.00	93.52	46.56	65.97	75.11

Note: The value in each cell indicates average separating efficiency values according to the sieve oscillating frequency, feed rate and sieve inclination.

Figure 9 Separating efficiency values of rosemary separating unit



2 mm round hole sieve

	14.0% 190	14.0% 380	14.0% 570	15.8% 190	15.8% 380	15.8% 570	17.6% 190	17.6% 380	17.6% 570
35 Hz	1.07	1.22	2.32	0.75	1.99	2.72	1.38	2.02	4.22
40 Hz	1.02	1.41	3.55	0.89	2.54	3.72	1.38	2.20	3.79
45 Hz	1.32	1.38	3.78	1.31	2.26	3.96	1.03	3.56	3.84

4 mm round hole sieve

	14.0% 190	14.0% 380	14.0% 570	15.8% 190	15.8% 380	15.8% 570	17.6% 190	17.6% 380	17.6% 570
35 Hz	0.87	2.37	2.83	0.80	1.85	2.45	0.89	1.94	2.84
40 Hz	1.11	2.58	3.53	1.20	2.68	3.83	1.27	4.00	3.43
45 Hz	1.67	3.34	4.82	1.72	4.00	4.24	1.46	2.90	3.56

4-20 mm oblong sieve

	14.0% 190	14.0% 380	14.0% 570	15.8% 190	15.8% 380	15.8% 570	17.6% 190	17.6% 380	17.6% 570
35 Hz	1.01	2.34	2.95	1.04	2.68	2.68	0.89	2.67	3.41
40 Hz	1.23	2.27	4.10	1.39	2.98	4.14	1.49	2.53	3.19
45 Hz	1.26	3.52	4.93	2.53	3.64	5.52	1.39	2.53	4.37

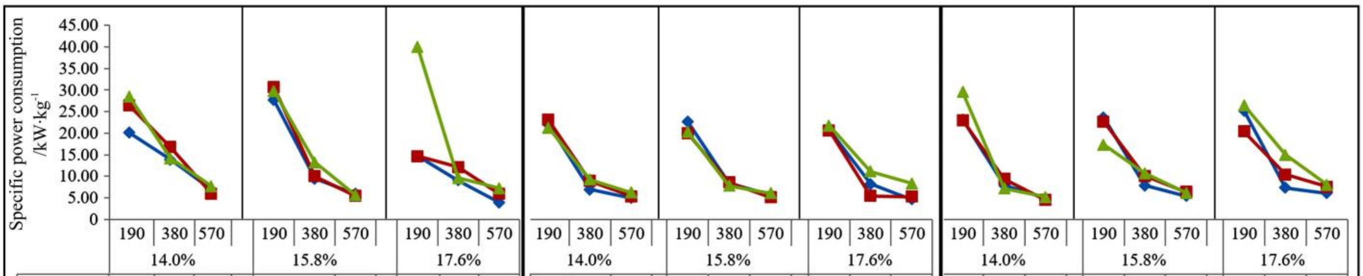
Note: The values in each cell indicate average work efficiency values according to the sieve oscillating frequency, feed rate and sieve inclination.

Figure 10 Work efficiency values of rosemary separating unit

According to the results of the experiments, the lowest work efficiency value was found as 0.75 kg/h at 15.8% sieve inclination, 35 Hz sieve oscillating frequency and 190 kg/h feeding rate in the Specific power consumption values for the system design must be determined and known for the system performance of the separation unit. The specific power consumption values of the separation unit for rosemary plants made with three different sieve types are given in Figure 11.

The specific power consumption values of the separating system varied between 3.95 kW/kg and 39.95 kW/kg.

The triple interaction of speed, feed rate and sieve slope on the specific power consumption with three different sieves were found statistically significant (p<0.05). While the specific power consumption of separating unit for rosemary plant was lowest at 570 kg/h feeding rate and 35 Hz of sieve oscillating frequency, it was highest at 190 kg/h feeding rate and 45 Hz sieve oscillating frequency. Each result was obtained from experiments performed with a 2 mm round hole sieve and 17.6% sieve inclination.



2 mm round hole sieve

	14.0% 190	14.0% 380	14.0% 570	15.8% 190	15.8% 380	15.8% 570	17.6% 190	17.6% 380	17.6% 570
35 Hz	20.12	13.87	6.97	27.68	9.41	5.89	14.64	9.08	3.95
40 Hz	26.39	16.80	6.01	30.68	10.0	5.44	14.64	12.1	6.03
45 Hz	28.42	14.23	7.72	29.80	13.2	5.58	39.95	9.61	7.28

6 mm round hole sieve

	14.0% 190	14.0% 380	14.0% 570	15.8% 190	15.8% 380	15.8% 570	17.6% 190	17.6% 380	17.6% 570
35 Hz	22.08	6.92	4.97	22.73	8.30	5.69	20.79	8.20	4.64
40 Hz	23.09	8.88	5.34	19.98	8.55	5.12	20.69	5.45	5.28
45 Hz	21.27	9.20	6.24	20.33	7.77	6.05	21.73	11.1	8.37

4-20 mm oblong sieve

	14.0% 190	14.0% 380	14.0% 570	15.8% 190	15.8% 380	15.8% 570	17.6% 190	17.6% 380	17.6% 570
35 Hz	23.17	7.90	4.88	23.66	7.89	5.44	25.26	7.31	6.06
40 Hz	23.04	9.38	4.50	22.68	10.1	6.38	20.43	10.4	7.54
45 Hz	29.59	7.15	5.20	17.35	10.7	6.19	26.50	14.9	8.03

Note: The value in each cell indicates average specific power consumption values according to the sieve oscillating frequency, feed rate and sieve inclination.

Figure 11 Specific power consumption values of rosemary separating unit

4 Conclusions

When the machine is evaluated in terms of threshing efficiency, it is suggested to operate the threshing unit at 14 mm drums clearance, 570 k/h feed rate and 250 r/min.

It should be recommended that for the proper work efficiency, the thresher can be operated 14 drums clearance, 570 kg/h feed rate and 400 r/min drum speed.

The working parameters need to be adjusted as 14 mm drums clearance, 190 kg/h feed rate and 100 r/min drum speed for the minimum power requirement.

The operating parameters of the threshing unit should be selected 16 mm drums clearance, 570 kg/h feed rate and 100 r/min for the low specific energy consumption.

When the separating unit for the rosemary plant is evaluated in the way of separating efficiency and work efficiency, it has been recommended to operate the machine with 4-20 oblong sieve at 380 kg/h feed rate, 45 Hz sieve oscillating frequency and 15.8% sieve slope.

The operating parameters of separating units were specified as 14.0% sieve slope, 570 kg/h feeding rate and 35 Hz sieve oscillating frequency with 10 mm round-hole sieve.

From the result above, it is clear that the optimum operating parameters of the rosemary threshing unit to improve efficiency are 14 mm drums clearance and 250 or 400 r/min drum speed. On the other hand for the high yield, the separating parameters should be chosen as 17.6% sieve slope 40 Hz sieve oscillating frequency with 4-20 mm oblong sieve.

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