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DETERMINATION OF THREHSING PERFORMANS OF NEW DESING THRESHING UNIT FOR SAGE•

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Abstract

The Sage (Salvia officinalis), Lamiaceae family, most of the Mediterranean countries are spread. Sage is one of the countries with the most collected are up to 90 species of sage in Turkey. Salvia officinalis species will be used in the scope of the research. Sage plants usually start to flower from May. Harvest time is the end of budding or flowering head.

In this study, the threshing system performances required for Sage (Salvia officinalis) have been determined. The threshing efficiency, work efficiency, power requirement and specific energy consumption values of the threshing unit developed were determined. In order to determine the threshing performance of the prototype, experiments were made at 3 different moisture ranges, 3 different drum speed, 3 different drum-concave open and 3 different feeding rates. Each experiment was performed in 3 replicates. As a result, a total of 243 experiments were carried out for sage plant in the threshing experiments.

According to the study results, threshing efficiency for sage (Salvia officinalis) in the study have changed between 48.92% and 94.58%. Work efficiency of threshing unit has been changed between 1.43 kg/h and 11.87 kg/h. Power requirements and specific energy consumption of threshing unit have been determined as 0.202- 0.972 kW and 0.04-0.53 kWh/kg respectively.

Key words*: sage (Salvia officinalis), threshing, design, aromatic plant.*

INTRODUCTION

The genus *Salvia* (sage) of the family *Lamiaceae* com-prises nearly 900 species spread widely throughout the world, which correspondingly display marked morpho-logical and genetic variations according to their geo-graphical origin (Chalchat et al., 1988). Sage (*Salvia officinalis* L.) is widely used as a savory food flavoring as the dried leaves or concentrated as the essential oil (Heath, 1978). Sage (*Salvia officinalis* L.) and its products, such as EOs and oleoresins have been widely used as food flavourings and health promoting agents (Perry et al., 1999; Perry et al., 2003). It is also used in cosmetics, perfume and medicine (Tucker et al., 1980; Chalchat et al., 1988).

Numerous studies have carried out on sage plants, but work on the mechanization of the sage plant is limited. Harvesting, threshing and cleaning medical aromatic plants is very important. The sage plants have been wildly collected and processed from the nature. In recent years, however, studies carried out on cultivating some species have provided higher productivity and quality production. During the processing of these plants such as threshing of the products some problems are emerged and lead to the yield loss and damages on products. In order to overcome this problem, it is necessary to know the operating conditions and performance values of the machines designed according to the plant. In the course of determining of threshing unit performance threshing efficiency, seed damage, unbroken capsule percentage, specific energy consumption, power requirement are used (Sudanjan et al., 2002).

In this study, the threshing parameters and the system performance such as threshing efficiency, work efficiency, power requirement and specific energy consumption of a threshing unit designed and developed for sage (*Salvia officinalis*) have been determined.

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MATERIALS AND METHODS

The specific threshing unit designed for sage has been used during the performance experiments.
The threshing unit consists of 2 rasp bar type threshing cylinders, 2 gear motors, main frame of threshing unit, torque meter for power measurement, cylinders distance mechanism (Figure 1).
For this study, sage (*Salvia officinalis*) plants were harvested by hand from the experimental field in Suleyman Demirel University, Isparta, Turkey.

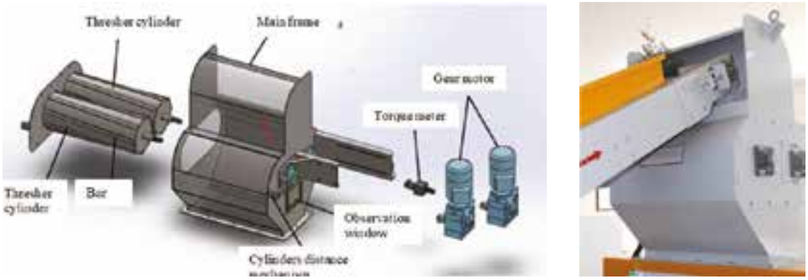

Figure 1. The threshing unit used in the experiments

In order to calculate the torque and the power consumed by the threshing unit a torque meter connected between the reducer electric motor and the drum shaft.
Sage (*Salvia officinalis*) plants have been dried in the rooms at 35°C after harvesting. In order to determine the threshing performance of system for sage plant the experiments have been conducted at 3 different moisture contents as 8.8%, 10.1% and 14.5% d.b.
The threshing cylinders (drum) speeds of the unit have been determined as 100, 250 and 400 rpm. Three different drum-concave open for the threshing unit have been adjusted as 15, 18 and 20 mm.
The product feeding rates have been determined as 190, 280, 570 kg/h. Each experiment has been performed in 3 replicates.
The operating parameters of the threshing unit for sage plant carried out at 3 different moisture contents have been given in Table 1.

Table 1. The operating parameters of the threshing unit for sage plant

Drum Speed (rpm)				Drum-Concave Opening (mm)		
Cylinder 1			Cylinder 2	1	2	3
1	2	3				
100	250	400	35	15	18	20

RESULTS AND DISCUSSIONS

Because of the experiments conducted depending on the moisture content of the sage, drum-concave opening, feeding rate and drum speed of the threshing unit, the threshing efficiency values have been range from 48.92% to 94.58% d.b.
The threshing unit efficiency for sage plant depending on the three different moisture contents are given in Figure 2.

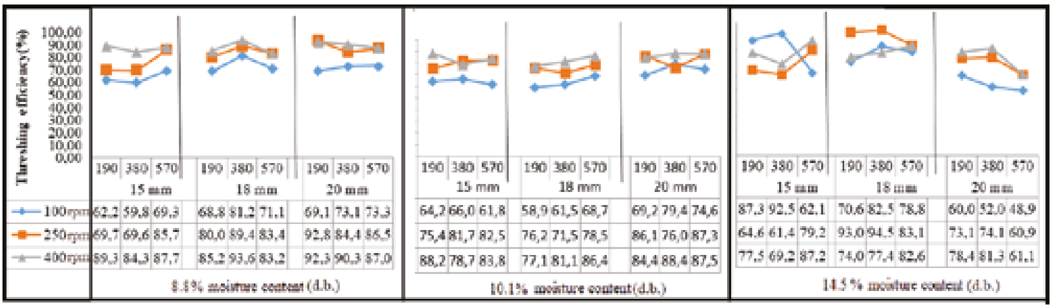

Figure 2. The effect of drum-concave opening × feeding rate× drum speed on the threshing efficiency at different moisture contents

As a result of the threshing experiments depending on the moisture content of the sage plant, the threshing efficiency have been decreased as the moisture content have been increased. The triple interaction of drum-concave opening × feeding rate × drum speed on the threshing efficiency at 8.8%, 10.1% and 14.5% d.b. moisture contents has have been found statistically significant ($p < 0.05$).

The highest threshing efficiency value has been found at 14.5% d.b. moisture content, 18 mm drum-concave opening, 250 rpm drum speed and 380 kg/h feeding rate. On the other hand, the lowest efficiency value has been found as. 48.92% d.b at the same moisture content, 20 mm drum-concave opening, 100 rpm drum speed and 570 kg/h feed rate.

According the result of the study conducted depending on the moisture content of the sage, drum-concave opening, feeding rate and drum speed of the threshing unit, the work efficiency values for sage plant was given in Figure 3.

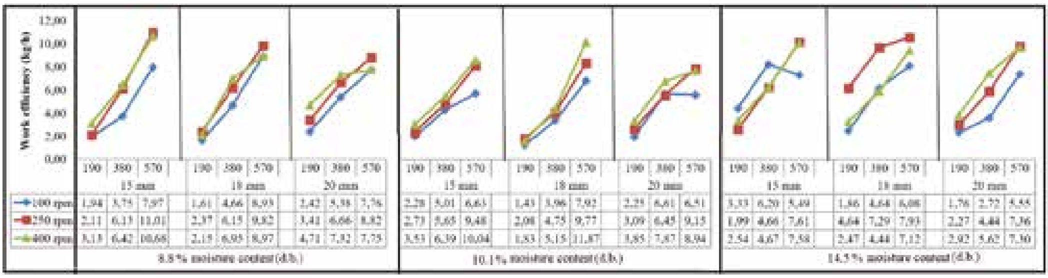

Figure 3. The effect of drum-concave opening × feeding rate × drum speed on the work efficiency at different moisture contents

According to the result of the study depending on the moisture content of the sage plant, the work efficiency has decreased with increasing moisture content. The triple interaction of drum-concave opening × feeding rate × drum speed on the work efficiency at 8.8%, 10.1% and 14.5% d.b. moisture contents has been found statistically significant ($p < 0.05$).

The work efficiency values changed between 1.43 kg/h to 11.87 kg/h. The highest and lowest work efficiency values have been found as 10.1% d.b. at same moisture content and as 18 mm at the same drum-concave opening. Whereas the lowest work efficiency value has been determined at 100 rpm drum speed and 190 kg/h feed rate, the highest values have been observed at 400 rpm drum speed and 570 kg/h feed rate.

Power requirement is one of the most important design parameters for threshing unit and it should be known for system performance. The power requirement values of the threshing units carried out at 3 different moisture contents are presented in Figure 4.

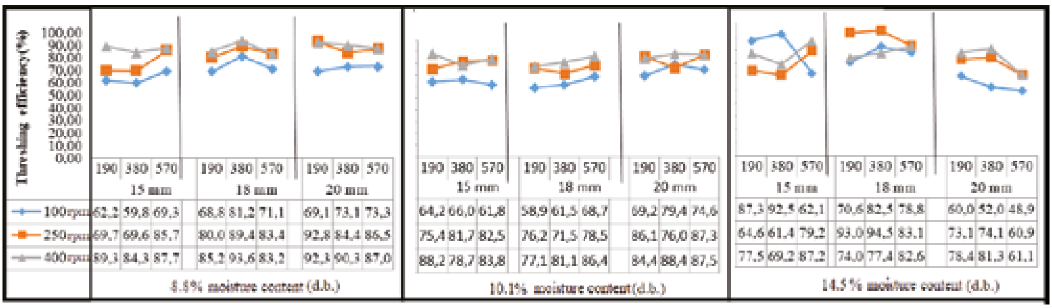

Figure 4. The effect of drum-concave opening × feeding rate × drum speed on the power requirement at different moisture contents

The power requirement values of the system according to the measured values depending on the moisture content of the sage, drum-concave opening, feeding rate and drum speed of the threshing unit, varied between 0.028 kg/h to 0.534 kg/h.

The triple interaction of drum-concave opening×feeding rate×drum speed on the power requirement at 8.8%, 10.1% and 14.5% d.b. moisture contents have been found statistically significant (p<0.05). Power requirement decreased as moisture content increased from 8.8% to 14.5% d.b.

While the lowest and highest power requirement of the threshing unit for sage plant have been determined as 0.028 and 0.534 kW at same moisture content of 8.8% d.b., respectively, the lowest and highest values have been obtained at 100 and 400 rpm drum speed, respectively. The drum-concave opening and feed rate values for minimum power requirement for threshing of sage plant is determined as 18 mm and 570 kg/h.

Specific energy consumption of sage plant must be known for the proper system performance of threshing unit.

The specific energy consumption values of the threshing unit carried out at three different moisture contents were varied from 0.028 to 0.534 kWh/kg and presented in Figure 5.

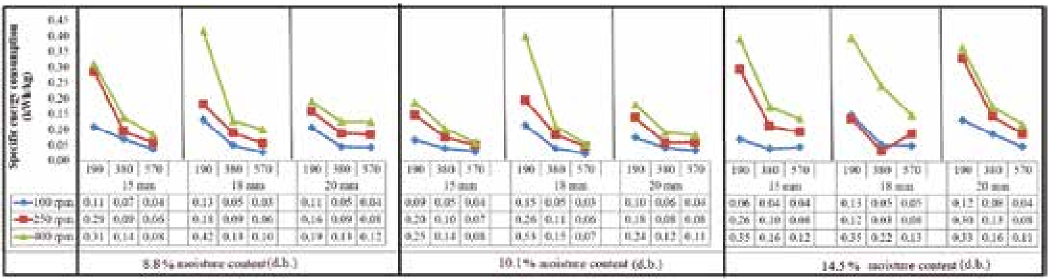

Figure 5. The effect of drum-concave opening × feeding rate × drum speed on the specific energy consumption at different moisture contents

The triple interaction of drum-concave opening×feeding rate×drum speed on the specific energy consumption at 8.8%, 10.1% and 14.5% d.b. moisture contents have been found statistically significant (p < 0.05).

The lowest specific energy consumption value of threshing unit for sage plant has been determined at 8.8% moisture content and the highest value has been observed at 10.1% d.b. While specific energy consumption of threshing unit for sage plant has been lowest at 18 mm drum-concave opening, 570 kg/h feeding rate and 100 rpm drum speed, it has been highest at 18 mm drum-concave opening, 190 kg/h feeding rate and 400 rpm drum speed.

CONLUSIONS

In this study, threshing unit performance values and working parameters have been determined for the sage plant, which has important cultivating areas for our country and Mediterranean region.

The threshing efficiency, work efficiency, power requirement and specific energy consumption values of threshing unit for the sage plant have been determined.

As a result, a total of 243 experiments have been carried out for the sage plant in the threshing experiments.

It is recommended to operate the threshing unit with 8.8% d.b. moisture content at 18 mm drum-concave opening, 380 kg/h feeding rate and 400 rpm drum speed in terms of threshing efficiency. On the other hand, it is suggested that for the high work efficiency, threshing unit can be performed with 10.1% d.b. moisture content, 18 mm drum-concave opening, 570 kg/h feeding rate and 400 rpm drum speed.

The working parameters must be selected as 8.8% moisture content, 18 mm drum-concave opening, 570 kg/h feeding rate and 100 rpm drum speed for the minimum power requirement and specific energy consumption.

The moisture content values for threshing of the sage plant are 8.8% and 10.1% d.b. The drum-concave opening can be selected as 18 mm and drum speed values is recommended as 400 rpm because of the sage leaf density.

ACKNOWLEDGEMENTS

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