# Effect of some operatiing factors on the efficiency of sweet lupine seeds milling procefss

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## ABSTRACT

The present study was carried out at on Arumon village, Kafrelsheikh Governorate, during 2014 seasons .using sweet Lupine seed. The objective of this work is used a small vertical milling machines, local manufactured prevalence our in Egyptian village Lupine sweet milling production is at moisture content ( 11 % w.b). The behavior of the particles and force acting them during grinding were studied in order to achieve the optimum conditions for milling operation. The effect of some parameters such as revolving speed ( 200, 250, 300 and 350 r.p.m ), discs clearance ( 1.0, 1.5 , 2.0 and 2.5 mm )and feeding rate (100, 150, 200 and 250 kg / h ) on the milling efficiency and energy required for milling of lupine sweet seeds were studied.

The obtained results are summarized as follows:

1 – The highest milling efficiency(90.3%) was obtained by milling of lupine sweet seeds at 300 r.p.m revolving speed, 1.5 mm discs clearance and 150 kg/h feeding rate.

2 - The energy requirement is high ( 8.2 to 10.1 kW / h) at increased revolving speeds ( 200 to 350 r.p.m) at discs clearance ( 1.5 mm) and feeding rates ( 150 to 300 kg / h), high throw decreasing discs clearance at all revolving speeds and feeding rates.

The maximum energy required (10.3 kW / h ) obtained by milling of lupine

sweet at 350 r.p.m revolving speed, 1 mm discs clearance and 250 kg/h feeding rate.

## INTRODUCTION

Milling process aims to mill the available grains into flour that meet the various needs of the flour consumer. Lupine flour can be used in production of different fermented products. It can be added to pasta, crisps, bread and emulsified meat products to increase nutritional value, aroma as well as modify the texture of

the end products. Moreover, protein isolate produced from lupine seeds can be utilized for milk and meat

imitation products. Seeds of white lupine have a protein content ranging from 33 % to 47%, according to genotype and location. Contrary to cereals, lupine proteins contain a high amount of lysine and a low amount of sulphur – containing amino acids **( Dervas et al ., 1999).** Oil content varies from 6 % to 13 % with a high concentration of poly unsaturated fatty acid **( Huyghe, 1997)**

**Erbas et al., (2005).** Showed that lupine contained high amounts of protein 32.2 %, fibre 16.2 %, oil 5.95 % and sugar 5.82 %. Oil 0f seeds was composed of 13.5 % saturated 55.4 % monounsaturated and 31.1 % polyunsaturated fatty acids sucrose constituted 71% of sugar content of seed. Lupine seeds contained 3.9 mg / kg of thiamin, 2.3 mg / kg of riboflavin and 39 mg / kg of niacin. It can be concluded that lupine is an excellent food material with a high nutritional value. **Matouk et al ( 1985)** reported that in roller mills, wheat grain pass

through break rollers and the products thirst pass through many pathways plus the plansifter and purifiers. In order to get the flour at the extraction rate of 87.7 % or higher, the millers has to re combine the required amount of flour. **Lineback et al.,( 1978)** reported that

milling wheat involves removing of the outer bran, which is valuable as roughage but indigestible by humans, to produce flour. The thickness of the bran is of interest because of its potential effect on milling behavior and flour yield. **Maynard and Heid ( 1964 ), and Kozmin ( 1988** ) classified the types of milling equipment according to the principles of action of their working organs upon the treated product as follow:

1 – Cutting ( chipping off ) machines.

2 – Pressing ( crushing ) machines.

3 – Machine acting by free impact.

Milling equipment may depend upon a single one of these actions or upon a combination of two or more. Mille also can be designed and frequently are to produce attrition and impact grinding. According to **Simmons**

**( 1963 ) and Kozemin ( 1988** ) showed that grinders may be placed in two categories:

1 – Stone grinders or mill stone:

a ,Horizontal grinders. (the top – runner type and the under – runner type)

b . Vertical grinders.

2 – Roller mills which can be designed to produce both compression and attrition grinding.

**EL. Hadidi et al (1996)** reported that, a small vertical milling machine was improved and tested. The behavior of particles and force acting on them during grinding were studied in order to achieve the optimum condition for milling operation. The effect of some parameters such as revolving speed, discs clearance and feeding rate on milling efficiency of wheat and maize grains. Results indicated that disc speed in the range of ( 300 to 350 r.pm), disc clearance of ( 1.5 – 2 mm) and feeding rate of 250 kg / h may be considered as optimum factors in milling process of wheat and maize grains. The energy requirements are higher in maize as compared with that needed for wheal grains at all speeds, clearance and feeding rates.

The main objective of the present study was tested and evaluating a small milling machine for local in Egyptian village lupine sweet milling production and requirement the most operating conditions.

## MATERIALS AND METHODS

The experiments were carried out at a small milling machine for local manufactured prevalence our in Egyptian village in Arumon, village-Kafrelsheikh Governorate, during 2014 seasons.

A – Materials :

1 – Variety Lupine grain.

Experiments were carried out on Lupine grain ( variety sweet lupine ). Some physical and mechanical properties of the used lupine grains are given in table ( 1 ) this properties the principles was related with operating factors optimum. The moisture content of grains at the time of experiment was 11 % w.b.

Table ( 1 ) Some physical and mechanical properties of sweet lupine grain. (werby et al 2012)

| | | |
|---|---|---|
| 1 | Average thickness, mm | 5.24 |
| 2 | Average width, mm | 10.87 |
| 3 | Average length , mm | 11.39 |
| 4 | Average ,repose angle | 14.43° |
| 5 | Average friction angle | 19.7° |
| 6 | The 1000 seed mass, g | 450 |
| 5 | Bulk densities g/ cm$^3$ | 0.0753 |
| 6 | Rupture force N | 210 |

2 – Milling machine :

- The vertical mill stone grinder installation used in this study as shown fig ( 1 ).

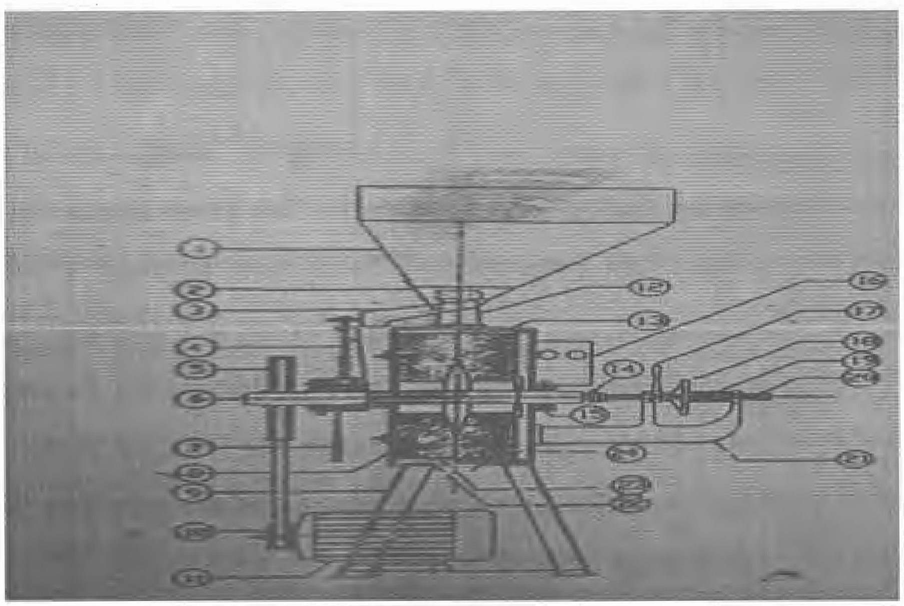

Figure. 1: A vertical section for proposal milling machine.

1- feed hopper 2 – sliding plate 3- shaker box 4 – shaker arm 5 – driving pulley 6 – horizontal shaft 7 – shaker handle 8 – casing 9 – frame 10 – motor pulley 11 – motor 12- hopper bracket 13- scraper 14 – thrust bearing 15 – bearing 16 – protect switch 17 – handle clutch wheel 18 - handle wheel 19 – pressure screw 20 – threaded bolt 21 – bracket 22 – flour outlet 23 – fixed stone 24 – runner stone

**-Frame:**

The overall frame is constructed from steel angles ( 75 x 75 mm ) welded together and fixed to the ground by four steel screws.

**The hopper:**

The hopper was installed to feed the grains into the shaker box. The sides of this hopper sloped gradually ( $20^0$ ) to keep the flow of grains at constant rate, the slope of controlling gate was changed by sliding plate using an arm operates manually. The hopper is set on a 2 - brackets and fixed with it, the brackets are mounted on a casing frame. The grain feed rate was controlled by a vibrating feeder. by an eccentric bushing which can be shifted along the shaft. The grain then drop from the hopper over the shaker box, then product stream is conveyed into the working space by worm spring on the horizontal shaft through the eye of the left hand stone. Four scraper blades are mounted on the rotating stone, these blades providing through the inlet up to the outlet an active air flow, both for conveyance and cooling of the grinding material.

**-Grinding chamber**:

Grinding chamber is made from iron sheet of 10 mm thickness on the shape of cylinder with diameter of 650 mm. In one side of the casing, the unmovable grinding stone is fixed while the runner stone is set on the other one. The runner stone is mounted on a horizontal shaft supported on three bearings with grease gun, two of which are attached on a foundation frame of the casing. The third bearing is set on the end of the driving shaft, it considered as sliding thrust bearing.The throwing of the stones apart and together is performed by means of a handle clutch witch consists of a lever handle connected to a coupling locking arrangement. The lever handle release the mill stones from each other, when pulling the handle, while the millstones will have their same selling, when the coupling hand is returned as before. The grinding pressure being regulated by a threaded blot which bears against a thrust bearing at the end of the driving shaft. The belt is screwed in or out by the hand wheel which moves the runner stone towards or away from the fixed stone. Coil springs: re inserted between the hand wheel and the end of the bracket, and the bolt is passing through its group by turning the hand wheel to the right or to the left, one may accurately regulate the distance between the grinding surfaces, but when the stones catch a big grain or any hard object between them, the runner presses hard upon the horizontal shaft which transmits the object away of the working space without causing any breakage. Since the runner is acting upon the spring it suppose to return the working space to its former position. A spiral spring is inserted on the horizontal shaft between the stones to prevents them from touching when the discs are revolving empty.

**-Source of power:**

The power source utilized to drive the milling machine was an electrical motor ( 1450 r.p.m , 11.3 kW ) the power from the source was transmitted by means of pulley and V belt.

**Experimental procedure:**

The effect of the following variables on the milling efficiency and energy requirement for lupine grains was studied some factory effects :

1 – Four stone speed of 200, 250, 300 and 350 r. p.m.

2 – Four stone clearance of 1, 1.5, 2 and 2.5 m

3 – Four feeding rates of 100, 150, 200 and 250 kg / h.

**- Milling efficiency test:**

The flour samples extracted from lupine were sieved by suitable standard sieves to separate the bran. The milling efficiency was calculated as percentage of the flour extraction to the total products using the equation as follows.

$$\text{Milling efficiency \%} = \frac{\text{flour extraction ( Kg/h)}}{\text{milling capacity (Kg / h)}} \times 100$$

**- Estimation of energy requirements:**

Super clamp meter – victor 6056B China made , was used for measuring the current and potential difference before and during experiments. Both ammeter and voltmeter were used for measuring current strength and potential difference respectively, before and during milling.

The total consumed electric power under machine working load ( kW ) was calculated according (Lockwood and Denstan, 1971) by the following equation.

Total consumed power = load.

$$\text{load} = \frac{I \cdot V \cdot \eta_m \cdot \cos\theta}{1000} \quad kW$$

$$(\text{No} - \text{load power}) = \frac{I \cdot V \cdot \eta_m \cdot \cos\theta}{1000} \quad kW$$

Useful power = load – (No – load,)

Where:

I : line current strength in amperes.

V : Voltage strength ( being equal to220 V).

$\cos\theta$ : power factor ( being equal to 0.85 ). $\eta_m$ : Mechanical efficiency 1s assumed ( 0.95)

**Productivity;**

Machine production: time of milling was measured by means of a stopwatch to determine the machine production in Kg / h.

$$\textbf{Productivity} = \frac{\text{mass of lupine seeds}}{\text{Time of milling}}$$

### Specific energy requirement

The specific energy requirement ( kW . h / kg ) was calculated by using the following equation:

The specific energy requirement kW . h / kg = (The consumed power (kW ) / Productivity ( kg / h ).

## RESULTS AND DISCUSSION

### Effect of rotation speed and stone clearance on milling efficiency:

The effect of rotation speed and stone clearance on the milling efficiency shown in fig. (2). Increasing rotation speed from 200 to 300 rpm increased the percentage of flour yield under all experimental conditions, after that decreased again with increasing of rotation speed to 350 rpm.Increasing rotation speed from 200 to 300 rpm at constant clearance of 1.5 mm and various feeding rates 100, 150, 200 and 250 kg / h increased the milling efficiency from ( 82.3 to 89), ( 82..2 to 90.3), (82.2 to 90.2) and (81.2 to 88.7) % respectively. Increasing stone clearance from 1 to 2.5 mm at rotation speed of 300 rpm and various feeding rates 100, 150, 200 and 250 kg / h decreased the milling efficiency from ( 89.1 to 82.2), ( 90.2 to 83), ( 90.1 to 83) and (89.6 to 83.1) % respectively. There was no significant interaction effect between feeding rate with rotation speed or discs clearance on milling efficiency .

The maximum milling efficiency(90.3%) obtained by milling of lupine sweet at 300 r.p.m revolving speed, 1.5 mm discs clearance and 150 kg/h feeding rate. The increasing rate of flour extraction of grains may be due to the severe continuous crushing of grains between the revolving stone and bed stone surface. These results were in agreement with Henderson and Hansen (1968) and Kozmin (1988).

**Effect of rotation speed and stone clearance on milling power requirement:**

The effect of different rotation speed, different clearance and feeding rates on the useful power needed for milled operation. Increasing the milling rotation speed tended to indicate milling power requirement for milled operation, as shown in fig. (3).

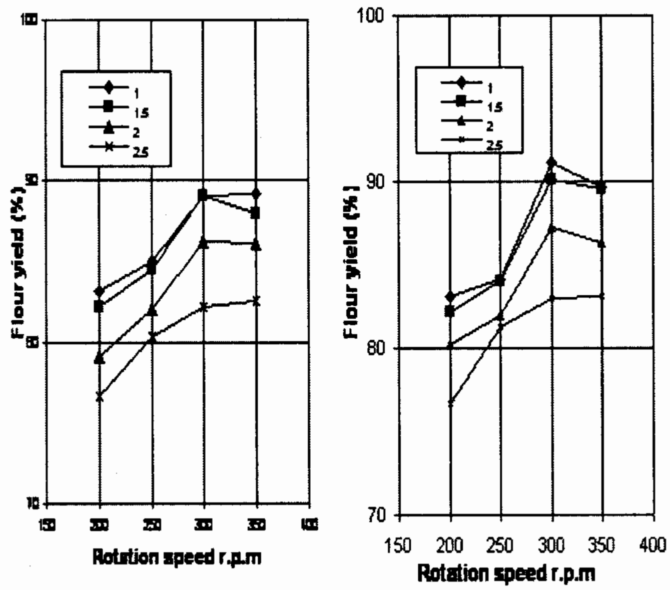


Fig. (2) Effect of different rotation at different discs clearance with efficiency% feeding rate 150, 200, 250 and 300 r.p.m on milling

increased the tended to increase the milling power requirement from ( 7 to 7.8 ), ( 8 to 8.5 ), ( 8.1 to 8.8) and (8.7 to 10.1 ) kW respectively. Increasing stone clearance from 1 to 2.5 mm at rotation speed of 300 rpm and various feeding rates 100, 150, 200 and 250 kg / h decreased the milling energy requirement from ( 8.5 to 6.6), ( 8.9 to 7.6), ( 9.2 to 7.7) and (9.9 to 7.9) kW respectively. Also, the results indicated that to increasing the feeding rates to increase the milling power requirement needed for milling operation with all revolving speeds and stone clearances .

The maximum milling power requirement (10.3 kW) obtained by milling of lupine sweet at 350 r.p.m revolving speed, 1 mm discs clearance and 350 kg/h feeding rate.

## CONCLUSION

1 – The milling efficiency was related positively with revolving speed and related inversely with discs clearance with all feeding rate. The highest value of milling efficiency was 90.3%. It was obtained by milling sweat lupine of revolving speed 300 r.p.m at disc clearance 1.5 mm and feeding rate 200 kg/ h.

2 – The energy requirement milling were related positively with revolving speed and is related inversely with discs clearance with all feeding rate. The optimum value of energy requirement was 8.4 kW /h. It was obtained by milling sweat lupine of revolving speed 300 r.p.m at disc clearance 1.5 mm and feeding rate 200 kg / h.

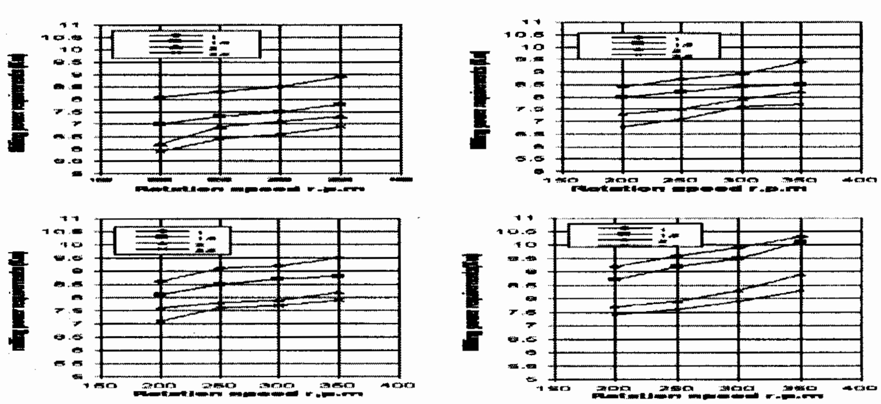

**Fig. (3) Effect of different rotation at different discs clearance with feeding rate 150, 200, 250 and 300 r.p.m on the milling power requirements.**

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## الملخص العربي

## تأثير بعض عوامل التشغيل علي كفاءة عملية طحن حبوب الترمس الحلو

د . رأفت علي أحمد وربي* د . أشرف كامل زعلوك* د . سمير حافظ الدسوقي*

نفذ هذا البحث في مطاحن محلية الصنع بقرية اريمون بمحافظة كفر الشيخ، خلال موسم ٢٠١٤ باستخدام حبوب الترمس الحلو ، وأجريت هذه الدراسة بهدف الاستفادة من المطاحن الصغيرة المنتشرة في الريف المصري، وتقليل تكاليف تشغيلها وذلك من خلال تقيم أداؤها في عملية طحن حبوب الترمس الحلو عند نسبة رطوبة (١١ %)لاختيار انسب ظروف تشغيل لإنتاج دقيق الترمس ، والتي يمكن من خلالها الوصول الي أعلي كفاءة لطحن دقيق الترمس للاستفادة منه، وذلك من خلال إضافته إلي دقيق القمح لتحسين خواص الخبز وسد جزء من احتياجات دقيق القمح لما تحتويه بذور الترمس من ٣٢,٢ بروتين ، وألياف ١٦,٢ ، وزيوت ٥,٩ ، وسكر ٥,٨٢ ، ورماد ٢,٦٥. (Eebas et al. 2005). فأضافه دقيق الترمس بنسبة من ٥ الي ١٠ % لتحل محل دقيق القمح لإنتاج الخبز أدي ذلك إلي تحسين ملحوظ في خواص العجينة من حيث الثبات ومقاومة الشد، ومن حيث الصفات الحسية للخبز فقد أعطت نتائج أيجابية من حيث توزيع اللبابة ولون الخبز مقارنة بالخبز المنتج من دقيق القمح ويمكن أن يدخل في تصنيع بعض الأدوية لما يحتويه من مركبات لها دور فعال في خفض الكولسترول ومضاد للسرطان . وكان الهدف دراسة بعض عوامل التشغيل الآتية :

١ – سرعة دوران اقراص الطحن ( ٢٠٠ ، ٢٥٠ ، ٣٠٠ و ٣٥٠ لفة / دقيقة ).

٢ – الخلوص بين الاقراص ( ١ ، ١,٥ ، ٢ ، ٢ و ٢,٥ مم ).

٣ – معدل التغذية ( ١٠٠، ١٥٠ ، ٢٠٠ و ٢٥٠كجم / ساعة ).

للوصول إلى أعلي كفاءة تشغيل

أوضحت النتائج ١ – ارتفاع كفاءة الطحن ( ٩٠,٣ % ) عند سرعة دوران ٣٠٠ لفة / د مع خلوص بين الأقراص ١,٥ مم ومعدل تغذية ٢٠٠ كجم / س.

٢ – كما أوضحت النتائج أن الطاقة المطلوبة للطحن تزداد بزيادة سرعة دوران الطحن لكل الخلوص بين الأقراص ومع كل معدلات التغذية وتنخفض مع زيادة الخلوص بين الأقراص مع كل سرعات الدوران ومعدلات التغذية المختلفة وكانت اعلي قدرة مطلوبة( ١٠,٣ kW ) مع استخدام سرعة دوران للقرص ٣٥٠ لفة / د وخلوص بين الأقراص ١ مم ومعدل تغذية ٢٥٠ كجم / س