

## Using of dimensional analysis to determine the parameters of gravity separator table device to minimize impurities in bulk lentils

H. Bagheri<sup>1</sup> - M. Rasekh<sup>2\*</sup> - M. H. Kianmehr<sup>3</sup>

Received: 11-06-2015

Accepted: 04-10-2015

### Introduction

Lentil (*Lens culinaris medic*) is an important and highly nutritious crop belonging to the family of legumes. Lentil is cultivated worldwide but competition with weeds is a problem affecting production and can reduce yield by more than 80%. The study on the separation of impurities in bulk lentils (*Euphorbia helioscopia weed*, *Wild oat weed* and etc.) by a gravity separator has an extreme importance. Since no study has been done to date, in this study, the effects of different parameters of a gravity separator (longitudinal and latitudinal slopes, oscillation frequency and amplitude) on the separation of foreign matters in lentil seeds were evaluated. A dimensionless number ( $v/a\omega$ ) which shows ration of air current velocity blown to lentil to the maximum velocity of table oscillation, was considered in ratio of separation.

### Materials and Methods

In this research, lentil samples were taken from farms in Ardebil Province (Bileh-Savar cultivar). A gravity separator apparatus was also used for separating impurities from lentil seeds. A Laboratory Gravity Separator Type LA-K (Westrup A/S Denmark) was used to separate impurities from bulk lentils. In this machine, table settings were as follows; longitudinal slope parameters ( $1^\circ$ ,  $1.5^\circ$ ,  $1.75^\circ$ ,  $2^\circ$  and  $2.5^\circ$ ), latitudinal slope ( $0.5^\circ$ ,  $1^\circ$ , and  $1.5^\circ$ ), frequency of oscillation (380, 400, 420 and 450 cycles  $\text{min}^{-1}$ ), and amplitude of oscillation (5 and 7 mm), these settings were all adjustable. Similarly, the instrument had 5 boxes whereby, through proper adjustment, the heavier material was transferred toward the right side of the table and lighter material moved toward the left side. Through proper adjustment of the main parameters of the instrument, the impurities were separated from bulk lentils. Then using an electronic seed counter, five groups of seed which each group containing 100 seeds were counted and selected.

### Results and Discussion

The results of variance analysis of the factorial design with three factors of table settings; (longitudinal slope at 5 levels, latitudinal slope at 3 levels, and frequency of oscillation of the table at 4 levels) are demonstrated in Table 1. It showed the main effect of table settings. Oscillation of frequency, latitudinal slope, and longitudinal slope, the mutual binary effect of latitudinal and longitudinal slope, the mutual binary effect of the latitudinal slope and the frequency of oscillation, the mutual binary effect of the longitudinal slope and the frequency of oscillation and the mutual triple effect of oscillation frequency, longitudinal slope, and latitudinal slope, were significant at the probability level of 1% and the mutual binary effect of the latitudinal slope and frequency of oscillation significant at the probability level of 5%.

The results showed that increase of latitudinal slope of table and increase of longitudinal slope from 1 to 2 degrees will increase the separation percentage of impurities from lentil seeds. Moreover, the separation percentage of impurities from lentil seeds to longitudinal slope, under the various latitudinal slope and dimensionless number of ( $v/a\omega$ ) and amplitude of oscillation of 5 mm and 7 mm, were investigated. Results showed that in all conditions with increasing of the longitudinal slope from  $2^\circ$ - $2.5^\circ$ , separation percentage of impurities from bulk lentils will decrease. This was due to the fact that under the stated conditions, distribution of seeds on the surface of the table was more homogenous. Note that at the amplitude of oscillation of 7 mm, transference of materials towards the right side of the table output edge was halted and the surface of the table

1- Ph.D. Student, Department of Biosystems Engineering, Faculty of Agricultural Technology and Natural Resources, University of Mohaghegh Ardabili, Ardabil, Iran

2- Associate Professor, Department of Biosystems Engineering, Faculty of Agricultural Technology and Natural Resources, University of Mohaghegh Ardabili, Ardabil, Iran

3- Professor, Department of Biosystems Engineering, University of Tehran, College of Abouraihan, Pakdasht, Iran

(\*- Corresponding Author Email: dr.mara1349@gmail.com)

was not fully covered by the fed materials, and separation decreased. The results of the experiment showed that the maximum separation of impurities from bulk lentils was 90.2 percent ( $\frac{v}{a\omega} = 171$ ).

### Conclusions

1- Increased latitudinal slope of the table from  $0.5^\circ$  to  $1^\circ$  and longitudinal slope of table from  $1^\circ$  to  $2^\circ$  were resulted in increased separation percentage of impurities from bulk lentils.

2- The results demonstrated that at settings of longitudinal slope of  $2^\circ$ , latitudinal slope of  $1^\circ$ , and frequency of oscillation of  $400 \text{ cycles min}^{-1}$ , air velocity of  $5.7 \text{ m s}^{-1}$  and amplitude of oscillation of  $5 \text{ mm}$  ( $\frac{v}{a\omega} = 171$ ), the maximum separation will be 90.2%. In this case, the output lentil seeds contained the least amount of impurities here.

**Keywords:** Dimensional analysis, Dimensionless number, Gravity separation, Impurities, Lentil