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QUALITY CONTROL CHARTS FOR HAZELNUT UNSHELLING OPERATION

KALİTE GÜVENCE ÇİZGELERİNİN FINDIK KIRMA İŞLEMİNDE KULLANILMASI

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Özet

Kalite güvence çizgelerinden olan p-çizgeleri, fındık kırma işleminde, 3 ayrı boy Akçakoca fındığında, vurgunlu ve geri-dönen özürleri için çizildi. p-Çizgeleri fındık kırma işleminin izlenmesinde, iyileştirme olasılıklarının belirlenmesinde ve gerekli tedbirlerin alınmasında kullanılabilir. Her boy, randıman ve üretim bölgesi için ayrı bir p-çizgesi çizmek gereklidir.

Abstract

The p-charts were constructed for 3 different diameter grades of Akçakoca hazelnuts for damaged and recyclable hazelnut units for hazelnut unshelling operation. The p-charts satisfactorily monitored the hazelnut unshelling operation, pointed out possible improvements and necessary precaution to be taken both operation and as maintenance. The results indicate that it may be necessary to construct p-charts of damaged and recyclable hazelnut units for each diameter grades and for different percent kernel and production region.

INTRODUCTION

Wild species of hazelnut, genus *Corylus*, are distributed in nearly all parts of temperate zones of the northern hemisphere while the major producers are Turkiye, Italy, Spain, and USA (Ayfer et al., 1986). Economically important varieties in Turkiye are selected from *C. Avellana var. pontica* (common hazelnut), *C. maxima mill.* (the giant hazelnut), and *C. Colurna var. glandulifera.* (Turkish hazelnut) (Ayfer et al., 1986; Kasaplıgil, 1972). Turkiye produces 400,000-450,000 tons of hazelnut annually. It is 73% of the total hazelnut production of the world. Turkiye exports 83% of its production, and gets about 750 million US$ annually (Anonymous, 1995). Almost eight million people are involved into production and processing of Turkish hazelnut (Akdağ and Öztürk, 1993). Hazelnuts provide a definite flavour in food products and plays a major role in human nutrition and health (Woodroof, 1967; Woodroof, 1973; Woodroof, 1975; Labell, 1983; Villaroel et al., 1987; Mattson, 1989; Elvevol et al., 1990; Nicolosi et al, 1990; Mehlenbacher, 1989; Labell, 1992; Sabate et al., 1993; Kinderlerer and Johnson, 1992; Garcia et al., 1994; Alphan et al., 1996; Pala et al., 1996).

Hazelnut Unshelling

Hazelnuts are unshelled by applying compression force on while passing through a clearance that is sufficient to avoid injuring the hazelnut kernels (stone, conical, and roller unshellers). Traditionally, hazelnuts are unshelled with stone unsheller in Turkiye (Figure 1). Damage occurring during unshelling is among the major causes of quality reduction in Turkish hazelnuts (Ayfer, 1984; Sabır, 1988). In Spain, hazelnuts are remoistured from 5-6% to about 10% prior to unshelling hazelnuts with conical unsheller to minimise damaged and broken. After unshelling, hazelnut shells are then siphoned by air suction during which undersize and broken kernels are also separated. The remaining hazelnut units are then passed over oscillating shaker screens and separators which separates recyclable hazelnuts from the kernels (Fig. 2). (Özdemir, 1996).

Quality Control Charts in Food Processes

Quality control charts e.i., Shewart and attribute charts, are used for statistically representing the picture of a process, raw material, product quality in manufacturing industries. They are real-time feedback to manufacturing operators to detect and give immediate response to any adverse signal in timely and to maintain the process under statistical control for a given lot (Hubbard, 1990; Levinson, 1992). They are simple in concept, easy to construct and understand for everyone. Shewart control charts consist of means and range charts, and are used with measured properties (Grant and Leavenworth, 1980; Miller and Freund, 1985; Hubbard, 1990; Montgomery, 1991). Attribute charts (p-, np-(m-), c- and u-charts) are commonly used when each unit in a sample set is assessed on the basis of either conforming or non-conforming according to the pre-determined quality attributes. The p-charts are based on the normal curve approximation of the binomial distribution model. This procedure is used when the defective units are distributed around a mean value following the binomial distribution model, and the shape of this distribution curve resembles to that of the normal distribution, therefore the properties of the normal distribution model may be used to construct the p-chart (Özilgen, 1997). The p-charts for a attribute may be constructed using the following equations 1, 2, 3 (Hubbard, 1990).

$$\text{Central line (CL)} = \overline{P} = \frac{\text{Total number of defectives in the samples}}{\text{Total number sample units}} \qquad (1)$$

$$\text{Upper control limit (UCL)} = \overline{p} + 3\left(\sqrt{\frac{\overline{p}(1-\overline{p})}{\overline{n}}}\right) \qquad (2)$$

$$\text{Lower control limit (LCL)} = \overline{p} - 3\left(\sqrt{\frac{\overline{p}(1-\overline{p})}{\overline{n}}}\right) \qquad (3)$$

Where $\overline{n}$ is the average sample size. Central line is actually an approximation of the population mean value of p. Equations 2 and 3 describes the upper and the lower control limits, such that the values of p determined in the individual experiments fall between these limits with about 99.7 % probability (Özilgen, 1997).

In the present study, we will use p-charts to statistically represent fraction of recyclable and damaged hazelnut units of 3 diameter grades of traditional Turkish unshelling operation.

MATERIALS AND METHODS

The hazelnuts

Akçakoca hazelnuts were used in the study. The hazelnuts consisted of a mixture of various local cultivars (Mincane, Karafindik, Foşa and Çakıldak) (Ayfer et al., 1986) and are supplied from large district, including Bolu, Adapazarı and Samsun provinces (Turkish Standards, 1978a). The hazelnuts contained 5 to 6% m.c. (d.b.). The percent kernel (the ratio of the kernel weight to the whole hazelnut weight) was 48%. This study was conducted in a commercial hazelnut processing plant.

Analysis of the unshelled hazelnuts

Quality attributes of the hazelnuts after unshelling are depicted in Table 1. These quality attributes are defined in the Turkish Standards (1978b) except for recyclable which were defined to be sum of the cracked, left-in-the-shell, and unbroken hazelnut units as a measure of capacity usage of the unsheller. Recyclable units were recycled to the unsheller continuously. A kernel may actually be damaged, but be regarded undamaged in the commercial sense if the diameter of the damaged area is less than 2 mm and its depth is less than 1 mm. For the diameter grades of 19-20 mm, 17.5-18 mm, 17-17.5 mm, samples of 1 kg weight were taken from 10 consecutive unshelling operations of acceptable quality level and analysed for the visible defects as defined in Table 1. Then, the p-charts of the diameter grades were constructed using Equations 1, 2, 3 for damaged and recyclable hazelnuts.

Table 1
Quality attributes of the hazelnuts unshelling operation (Turkish Standards, 1978b)

Attributes	Definition
Damaged	kernels with damage greater than 2 mm in diameter, and 1 mm in depth
Undamaged	kernels with no damage or damage smaller than 2 mm in diameter
Broken	kernels which lost at least one-third of their edible part
Cracked	hazelnuts whose shell was intact with only a minor crack
Left-in-the-shell	kernels, trapped inside a partially broken shell (at least one-sixth of the shell is broken)
Unbroken	hazelnuts that have a completely unbroken shell
Recyclable[1]	total percentage that may be recirculated to the unshellers (sum of the percentages of left-in-the-shell, cracked and unbroken hazelnuts)

[1]*Not defined in Turkish standards (See material and methods section)*

RESULTS AND DISCUSSION

The p-charts highlight quality and capacity problems, and standardise the operation. The operating conditions of the unsheller are determined by the operator of the unshelling plant. The aim is to have lowest possible damaged hazelnuts with maximum undamaged for the given diameter grade at a acceptable level recyclable hazelnut units. It depends on experience of the operator of the hazelnut unshelling plant (Özdemir, 1996; Özdemir and Özilgen, 1997). So as to monitor the unshelling operation for damaged and recyclable hazelnuts, fraction of the damaged or the recyclable hazelnuts (values of p) were determined in each experiment, then the central line, upper and lower control limits of the p charts were determined by using Equations 1, 2 and 3 respectively (Table 2). LCL of the 19-20 mm and 17.5-18 mm hazelnuts had a negative value, therefore they were set to be zero. Separate p-charts for the damaged and recyclable hazelnuts were constructed for the 19-20 mm, 17.5-18 mm, and 17-17.5 mm diameter grades as shown in Figs. 3, 4 and 5. The percent variation of the sample size, calculated by dividing the difference of maximum and minimum sample sizes to average sample size, was smaller than the recommended value (20%) in all of the trials (Table 2) (Hubbard, 1990). The unshelling operation is regarded under statistical control to the given standard, when the experimental data fall between the upper and the lower control limits of the predetermined quality factors. Figs. 3a, 4a and 5a indicate that the operation was within statistical control, when the fraction of the damaged hazelnuts are chosen as the quality indicator. The average of damaged hazelnuts for 19-20 mm, 18-17.5 mm and 17-17.5 mm hazelnuts were ranging from about 0 to 1.4%, 2 %, 3 % respectively.

Table 2
CL, UCL and LCL values for the damaged and recyclable units

Diameter (mm)	% Variation	Defects	CL	UCL	LCL
19-20	16.2	Damaged	0.005	0.014	0.0
		Recyclable	0.375	0.439	0.312
17.5-18	15.5	Damaged	0.009	0.020	0.0
		Recyclable	0.242	0.289	0.195
17-17.5	14.7	Damaged	0.016	0.030	0.003
		Recyclable	0.266	0.313	0.220
17-17.5[1]	18.10	Damaged	0.048	0.070	0.026
		Recyclable	0.176	0.215	0.137

[1] *Data gathered from Özdemir and Özilgen (1997)*

Moreover, Figs 3b, 4b and 5b shows that the fraction of the recyclable hazelnuts was within the statistical control when recyclable units was chosen as a quality indicator. But, the averages of recyclable hazelnuts for 19-20 mm, 18-17.5 mm and 17-17.5 mm hazelnuts were ranging from 32.2 to 43.3%, 19.5 to 28.9%, and 12% to 31.3% respectively. This means about 1/3 capacity reduction during unshelling operation. Sizing hazelnuts into 20 grades instead of 14 may help to reduce recyclable percentage, and consequently increase the capacity. A acceptable quality is a compromise between the damaged and recyclable hazelnuts. For example, increasing recyclable fraction will probably result in lower fraction of damaged at the expense of reduced capacity, or vice versa. A higher damaged or recyclable hazelnut units than UCL will require tuning of the unsheller. Fractions of hazelnuts which experience permanent damaged above UCL may indicate enlarged active unshelling distance in the stones

(Fig. 1), which may occur as a results of stones and pieces of metal found a way into the feed units (Özdemir, 1996).

Besides unsheller characteristics, amount of damaged hazelnuts depends on the clearance between the shell and the kernels, thickness of shell and shape of the hazelnuts (Ayfer, 1973; Nalbant, 1991; Pınar and Beyhan, 1991). The clearance varies from year to year, and can be related to percent kernel (Özdemir and Özilgen, 1997). Özdemir and Özilgen (1997) constructed p-charts for Akçakoca hazelnuts with 50-52% kernel for 17-17.5 mm and 16.5-17 mm hazelnuts. They stated that the p-charts should be used with extreme caution for different region hazelnuts and different percent kernels.

The samples of 17-17.5 mm hazelnuts with 50-52% kernel were not within statistical control when they were analysed with p-charts of the same grade but 48% kernel (Fig. 6a). However, the recyclable hazelnut units of the 17-17.5 mm hazelnuts with 50-52% kernel were within statistical control when they were analysed with p-charts of the same grade but 48% kernel (Fig. 6b). Recyclable hazelnut fraction may be a characteristic of unsheller, and may not be effected from the percent kernel as much as the damaged hazelnuts. Nevertheless, it may be necessary to construct different p-charts of damaged and recyclable for each diameter grades and kernel percent, and for different production region.

The charts can be used by taking 1 kg sample from the shaker/separator inlet (Fig. 2) after adjusting the unsheller system to the new diameter conditions, and analysing the sample in terms of damaged and recyclable hazelnuts. If fraction of the attributes of the sample are within the UCL and LCL of the chart, the operation is within the statistical control for the given diameter grade.

CONCLUSION

The p-charts satisfactorily describes hazelnut unshelling operation. They enable to standardise the process and give immediate responses to the changes in product quality. However, it may be necessary to construct p-charts of damaged and recyclable hazelnut units for each diameter grades and kernel percent, and for different production region.

REFERENCES

Alphan, E.M. Yılmaz, T.M. Pala, M. and Açkurt, F. 1996. Tekli Doymamış Yağ Asidi İçeriği Fındıkla Zenginleştirilmiş Diyetin Karbonhidrat ve Lipid Metabolizmasına Etkisi. Gıda Teknolojisi, 1, 58-63.

Anonymous. 1995. Fındık Ekonomik Raporu. Fiskobirlik, Giresun.

Ayfer, M. 1973. İç Fındıklarda Gizli Vurgun Üzerine Bir Araştırma. Annual of Faculty of Agriculture of Ankara University, 23(3), pp. 269-284.

Akdağ, Z. and Öztürk, İ. 1993. Meyve-Sebze Işleme Sanayi Özel İhtisas Komisyonu Fındık İşleme Sanayi Alt Komisyon Raporu. In "Yedinci Kalkınma Planı," TC DPT, Ankara.

Ayfer, M. 1984. Dünya'da ve Türkiye'de Fındık. In "Türkiye Ekonomisinde Fındığın Yeri ve Önemi," İktisadi Araştırma Vakfı, İstanbul, pp. 33-55.

Ayfer, M. Uzun, A. Baş, F. 1986. Türk Fındık Çeşitleri. Black Sea Hazelnut Exporters Union, Ankara.

Elvevol, E.O. Moen, P. Olsen, R.L. and Brox, J. 1990. Some Possible Effects of Dietary Monounsaturated Fatty Acids in Cardiovascular Disease. Artheriosclerosis, 81, 71-4.

Garcia, J.M. Agar, I.T. and Streif, J. 1994. Lipid Characteristics of Kernels from Different Hazelnut Varieties, Tr. J. Agric. and Forestry, 18, 199-202.

Grant, E.L. and Leavenworth, R.S. 1980. Statistical Quality Control. 5th ed., Singapore, Mcgraw-Hill, pp. 1-29.

Hubbard, R.H. 1990. Statistical Quality Control for the Food Industry. Von Norstrand Reinhold, New York, pp. 29-51.

Kasaplıgil, L. 1972. A Bibliography on Corylus Betulaceae. 63. Ann. Rep. Of the Northern Nut Growers Associations.

Kinderlerer, J.L. and Johnson, S. 1992. Rancidity in Hazelnuts Due to Volatile Aliphatic Aldehydes. J. Sci. Food. Agric., 58, 89-93.

Labell, F.M. 1983. Hazelnut Paste Provides Sweet, Delicate Flavour. Food Processing USA, 44, 80.

Labell, F.M. 1992. Hazelnuts Supply Flavour and Crunch, Food Processing USA, 53, 52, 54.

Levinson, W.A. 1992. Make the most of Control Charts, Chemical Engineering Progress, 86-91.

Mattson, F.H. 1989. A Changing Role for Dietary Monounsaturated Fatty Acids. J. of the American Dietetic Association, 89, 387-391.

Mehlenbacher, S.A. 1989. Hazelnuts, in Genetic Resources of Temperate Fruit and Nut Crops. Acta Horticulture 290, International Society for Horticultural Science.

Miller, E. and Freund, J.E: 1985. Probability and Statistics for Engineers. Ed., E. Cliffs, 3rd Edn., Prentice-Hall Inc., pp.426-431.

Montgomery, C.C. 1991. Introduction to Statistical Quality Control. 2th Ed., John Wiley & Sons, pp. 101-146.

Nalbant, M. 1991. Fındık Kabuğunun Sıkıştırma ve Çarptırma Yöntemiyle Kırılması. Annual of Samsun 19th May University, pp. 115-130.

Nicolosi, R.J. Stucchi, A.F. Kewal, M.C. Hensesig, L.K. Hegstein, P.M. and Schefer, E.J. 1990. Effect of Dietary Fat Saturation and Cholesterol on LDL Composition and Metabolism. Arterisclerosis, 10, 119-128.

Özdemir, M. 1996. Statistical Assessment of Quality Parameters of Turkish Akçakoca Hazelnuts During Cracking Operation, MS thesis (Unpublished), METU, Ankara.

Özdemir, M and Özilgen, M. 1997. Comparison of the Quality of Hazelnuts Unshelled with Different Sizing and Cracking Systems. Accepted for publication in J. Agric. Engng. Res.

Özilgen, M. 1997. Chemical Engineering Applications for Food Process Modelling and Control, Gordon and Breach Publishing Group UK. (in press).

Pala, M. Açkurt, F. Löker, M. Yıldız, M. and Ömeroğlu, S. 1996. Fındık Çeşitlerinin Bileşimi ve Beslenme Fizyolojisi Açısından Değerlendirilmesi. Tr. J. of Agriculture and Forestry, 20, 43-48.

Pınar, Y. and Beyhan, M.A. 1991. Samsun and Ordu Yöresinde Fındık Tarımının Mekanizasyon Durumu. Annual of University of 19th May, Samsun, pp. 99-114.

Sabate, J. Fraser, G.E., Burke, K., Knutsen, S.F. Bennett, H. and Lindsted, K.D. 1993. Effects of Walnuts on Serum Lipid Levels and Blood Pressure in Normal Men. The New England J. Medicine. 328, 603-607.

Sabır, S. 1988. Türkiye’de Fındık Pazarlaması İhracat. In “Türkiye’ de Fındık Politikasının Esasları,” İktisadi Kalkınma Vakfı, İstanbul, pp. 103-116.

Turkish Standard. 1978a. Unshelled Hazelnut TS 3074. Institute for Turkish Standards, Ankara.

Turkish Standard. 1978b. Shelled Hazelnut TS 3075. Institute for Turkish Standards, Ankara.

Villarroel, M. Biolley, E. Schneeberger, R. Ballester, D. Ramirez, S. 1987. Amino acid composition of Chilean hazelnuts. Food Chemistry, 25, 155-158.

Woodroof, J.G. 1967. Tree Nuts, Production, Processing, Products. Avi Publishing Company Inc., Westport, Connecticut, Vol. 1, pp. 277-312.

Woodroof, J.G. 1973. Peanuts, Production, Processing, Products. 2nd Ed., Avi Publishing Company Inc., Westport, Connecticut.

Woodroof, J.G. 1975. Tree Nuts, Production, Processing, Products. Vol. 1. 2nd Ed.,. Avi Publishing Company Inc., Westport, Connecticut.

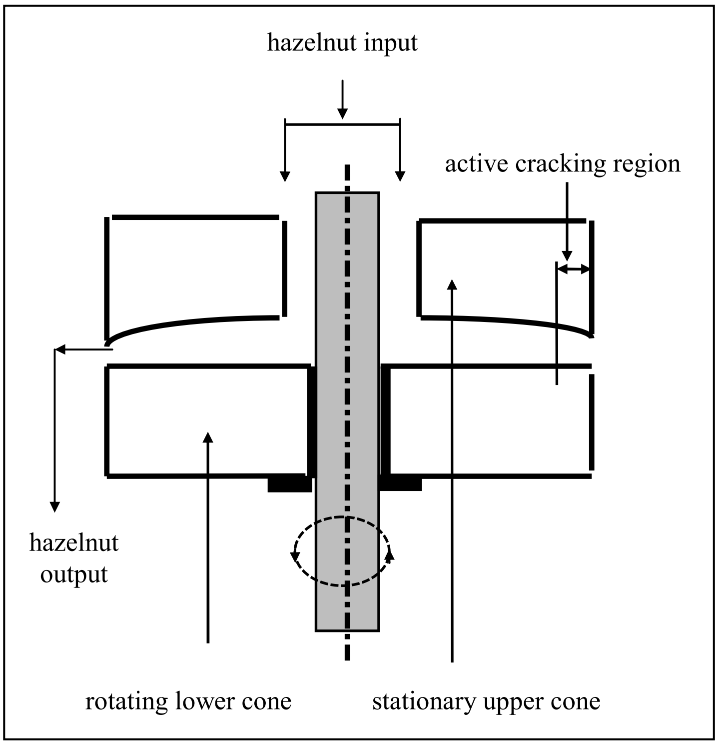

Figure 1: Stone unsheller (Adapted from Özdemir and Özilgen, 1997)

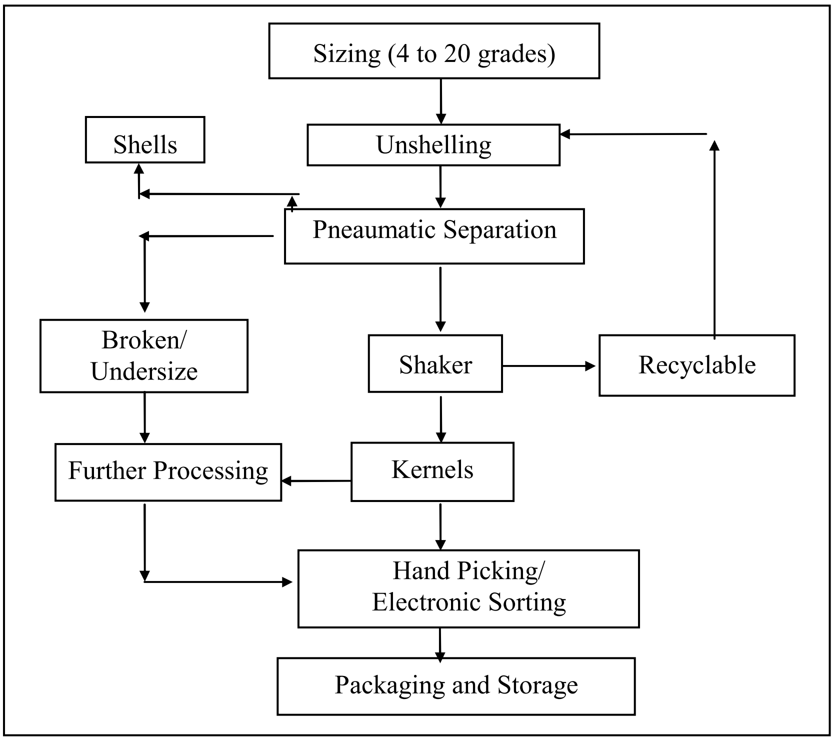

Figure 2: Hazelnut unshelling operation

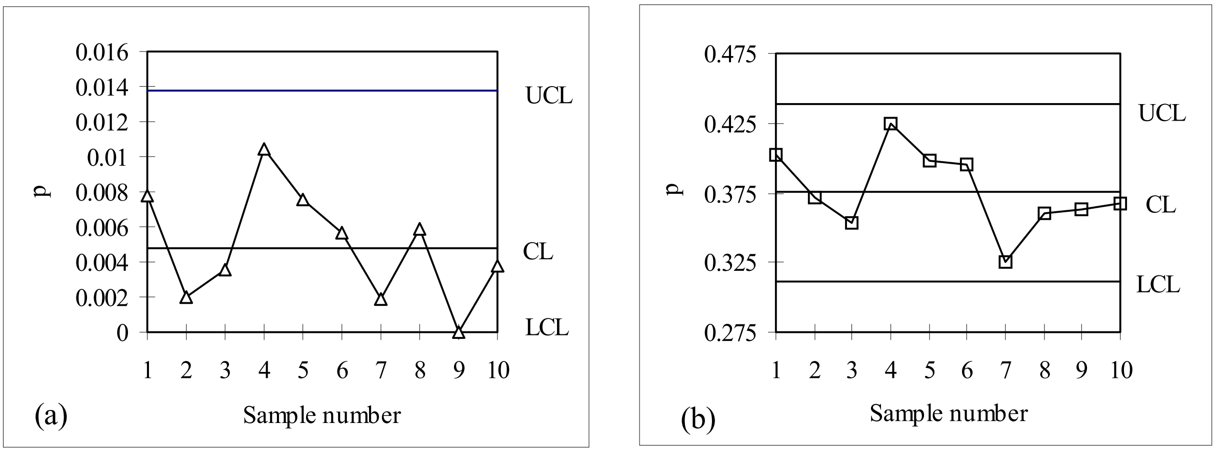

Figure 3 : P - chart for the (a) damaged (b) recyclable 19-20 mm hazelnuts

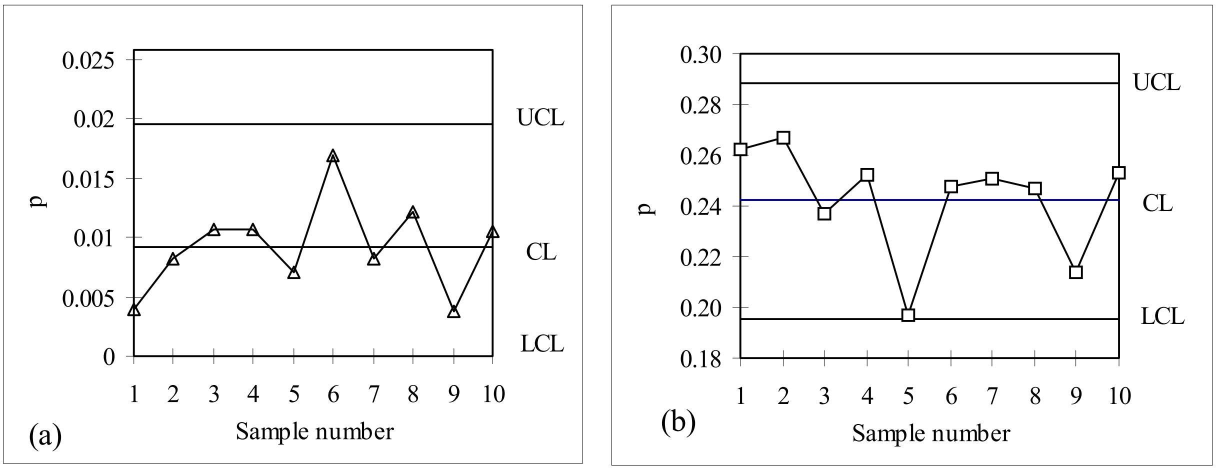

Figure 4 : P - chart for the (a) damaged (b) recyclable 17.5-18 mm hazelnuts

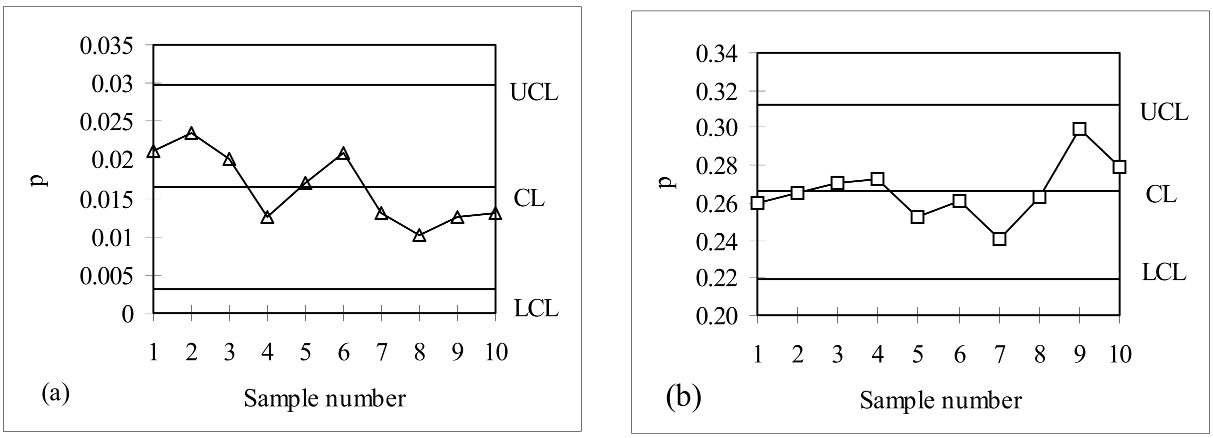

Figure 5 : P - chart for the (a) damaged (b) recyclable 17-17.5- mm hazelnuts

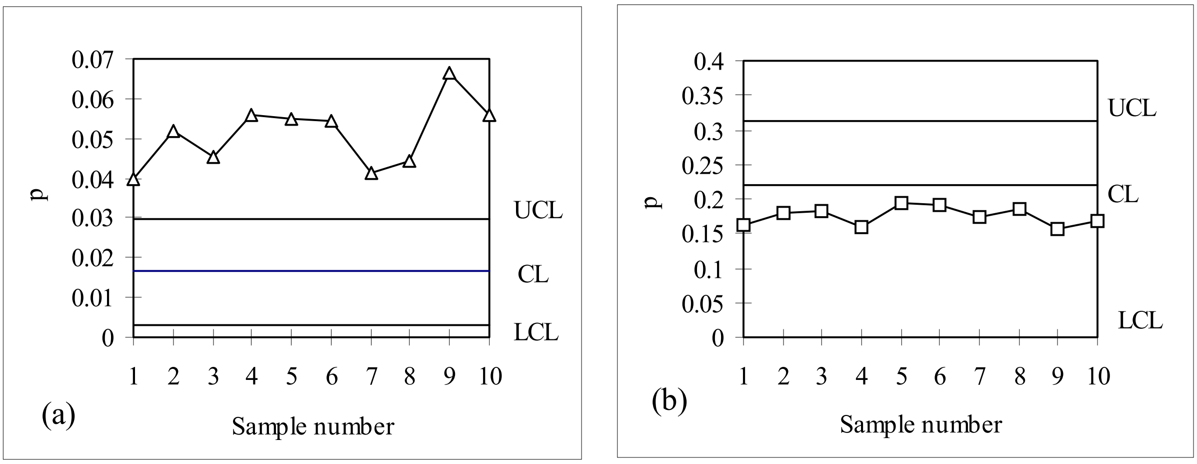

Figure 6 : P - chart for the (a) damaged (b) recyclable 17-17.5- mm hazelnuts (CL, UCL, LCL is of 48% kernel, samples are from 50-52% kernels (data of 50-52 % kernels were gathered from Özdemir and Özilgen (1997))