Effect of the environment on the chemical composition and some other parameters of sunflower seed quality

Velimir Radić, Siniša Jocić, Jelena Mrđa
[1]Institute of Field and Vegetable Crops, Maksima Gorkog 30, Novi Sad 21000, Serbia,
E-mail: vanjar@ifvcns.ns.ac.yu

ABSTRACT

Considering the area of sunflower cultivation in the world, the profit made by selling the seed varieties and sunflower hybrids, the number of companies whose business activity is related to production and selling of sunflower seed, the tendency of the struggle for taking the greatest market share is bigger and tougher. This type of competition conditions all seed companies to encourage as many producers as they can with their choice of hybrids and seed quality, all aimed at making bigger profits. The common argument of seed companies for attracting producers is the chemical composition of seed. Chemical composition of sunflower seed consists of great number of different organic compounds, the oil content and proteins being the most important. The objective this research has been to evaluate the differences appearing in seed quality parameters in two localities.

Key words: linoleic acid – oil content – oleic acid – seed germination – sunflower seed – tocopherols.

INTRODUCTION

Seed is the beginning of a plant's new life, a complex biological system and as such it is the first and basic factor of successful plant production (Milošević et al., 1996).

Seed quality is a complex category, determined by great number of factors (purity, germination, moisture, weight of 1000 seeds and others), which are under the influence of different environmental factors (Karagić et al., 2001). One of the most important characteristics of a seed is the germination energy and germination of a seed itself (Radić, 2003). The same author further mentions that great number of factors influence the germination such as climate conditions in time of production, pollination, fertility, harvest, factors that appear during the seed drying and seed cleaning (transport from a plot, method of drying, storage of natural seed, cleaning, seed treatment) as well as factors of storage of the seed (damage possibility by various warehouse insects as well as damage during the seed usage). Škorić et al., (1996) conclude that environmental factors can influence the chemical composition of a seed as well.

Sunflower is produced in more than 40 countries of the world (Putt, 1997). Considering the area that sunflower covers in the world, the profit made from selling the seed varieties and sunflower hybrids, the number of seed companies whose business activity is related to the production and selling of sunflower seed, the tendency of a struggle for taking the greatest market share is becoming bigger and tougher. This type of competition conditions all seed companies to encourage as many producers as they can in their choice of hybrids and seed quality, all aimed at making bigger profits.

The common argument of seed companies for encouraging producers is the chemical composition of seed and its use. Chemical composition of sunflower seed consists of great number of different organic compounds, but for sunflower, oil content and composition and protein content in seed are the most important (Marinković et al., 2003).

The same authors further mention that beside fatty acids, sterols, carotenoids, phosphates and some other compounds, the quality of oil is determined by the total amount of tocopherols, as well as the content of its respective forms.

During the process of breeding, breeders are helped by information about correlations that appear between the oil content in the seed and other characteristics of a plant and seed, since they make it possible to find connections that help or prevent the successful selection for these characteristics. Most authors have dealt with studying the relation of oil content and seed yield, plant height, weight of 1000 seeds, head diameter, number of leaves, dry matter obtained during the vegetation and others .

However, some authors have dealt with problems related to the influence of the environment on oil composition and content in sunflower seed. According to Škorić (1988) and Krizmanić et al. (1992), who take into account the environmental factors that have an effect on oil content, the average daily temperatures and the amount of moisture in the soil are the factors that have the biggest effect. Marinković et al., (2003) believe that the content of oil in seed is lower if the lack of soil moisture

appears in the period of flowering-maturation. Dušanić (1994; 1998) and De la Vega and Hall (2002) believe that the main cause of variations in content and composition of oil in sunflower seed, as well as for oil yield is the influence of the production year, locality and the sowing deadline.

The aim of the research described in this paper was to determine if the content of oil, α-tocopherol, linoleic and oleic acid in sunflower seed depends on the place of production, and if there are factors that can affect the sunflower seed germination.

MATERIALS AND METHODS

The research was made on seeds produced in two localities, Argentina and Serbia, in quite similar conditions of production. Two genotypes were used: HA-26-OL (high oleic type) and HA-48 (standard type). Complete research was carried out at the Insitute of Field and Vegetable Crops, Oil Crops Department.

During the research, the following parameters were used:

1. Germination – Examination of seed germination of both genotypes was repeated 6 times. Each time 50 seeds were used. Germination was determined after 10 days. Only naturally formed germed seeds were used for determination of this parameter. Germination was expressed in percentage.
2. Oil content – Determined by classical method and expressed in percentage.
3. Tocopherols content – The content of α-tocopherol was determined by liquid chromatography method (HPLC) and expressed in mk/kg oil.
4. Linoleic and oleic acid content – Determined by gas chromatography method. The content of these two acids is expressed percentage (% of the total fatty acids).

Computer programme GENSTAT was used for the analysis of variance of two factor experiment and interdependence of the observed parameters.

RESULTS AND DISCUSSION

The results of the research show that the percentage of seed germination of the two genotypes produced in a locality in Serbia was 64% and 71% respectively (Table 1), while for those produced in a locality in Argentina germination percentage of HA-26-OL was 97% and that of of HA-48, 96% (Table 2).

As for seed germination, lower values were determined for oil content for seed produced in a locality in Serbia (Table 1) than for seed produced in a locality in Argentina (Table 2). A percentage of 31.34% of oil content was determined for HA-26-OL genotype for seed produced in a locality in Serbia and 36.42% for seed produced in a locality in Argentina. For HA-48 genotype those values were 36.82% in Serbia and 48.90% in Argentina.

Table 1. Results on a locality in Serbia

Genotype	Seed germination (%)	Oil content and composition			
		Oil content (%)	α-tocopherol (mg/kg oil)	Linoleic acid (%)	Oleic acid (%)
HA-26-OL	64	31.34	425.67	19.63	72.73
HA-48	71	36.82	393.40	62.23	26.57

Similar situation was found during the observation of tocopherol content. For the seed obtained in a locality in Serbia a total tocopherol content of 425.67mg/kg oil was determined in HA-26-OL and 393.0 mg/kg oil in HA-48 genotype (Table 1). These values were higher than those obsserved for the seed obtained in Argentina for HA-26-OL (585.30 mg/kg oil) and for HA-48 genotype (569.45 mg/kg) (Table 2).

Considering that for this study a high oleic acid and a standard type hybrid were used, the content of linoleic and oleic acid was different between observed genotypes. Nevertheless, HA-26-OL had lower linoleic acid content (19.63%) in a locality in Serbia (Table 1) in comparison to the value observed in a locality in Argentina (35.83%) (Table 2). The same situation was observed for the HA-48 (standard type) genotype. In Serbia the result was 62.33% while in Argentina it was 67.23%.

In contrast to all observed characteristics, the content of oleic acid had a higher value in a locality in Serbia than in a locality in Argentina, in both genotypes observed (Tables 1 and 2).

Oleic acid content was 72.73% for HA-26-OL in a locality in Serbia, in comparison to 57.30% in Argentina. HA-48 had a oleic acid content of 26.57% in Serbia was 26.57% while in Argentina that value was 30.73%.

Table 2. Results in a locality in Argentina

Genotype	Seed germination (%)	Oil content and composition			
		Oil content (%)	α-tocopherol (mg/kg oil)	Linoleic acid (%)	Oleic acid (%)
HA-26-OL	97	36.42	585.43	35.83	57.20
HA-48	96	48.90	569.45	67.23	30.73

The calculation of simple coefficients of correlation, showed a highly significant positive correlation between seed germination and tocopherol content (Table 3). A highly significant positive correlation between oil content and linoleic acid content was also observed (Table 3). Škorić (1982) and Petakov et al. (1983) reached similar conclusions. A highly significant negative correlation between linoleic and oleic acid content was identified (Table 3).These values are in agreement with the results of Seiler (1994), while Gonzales et al. (2000) determined the existence of negative correlation between both fatty acids, even though the authors found that the correlation was not statistically significant.

A significant positive correlation was observed between seed germination and oil content. Correlation between oil content and oleic acid was significantly negative (Table 3). In their research, Álvarez et al. (1992) detected the existence of a highly significant positive correlation of oleic acid with and seed oil content and weight of 1000 seeds, while the correlation coefficient between linoleic acid content and seed yield was negative but not statistically significant.

A positive but not significant correlation was detected between seed germination and linoleic acid content, between oil content and tocopherol content, as well as between linoleic acid content and tocopherol content. A weak and negative correlation was observed between seed germination and oleic acid content , and between oleic acid content and tocopherol content (Table 3).

Table 3. Coefficients of correlation of the observed parameters

Parameters	Oil content	Linoleic acid	Oleic acid	Tocopherols
Germination	0.675*	0.392	-0.289	0.766**
Oil content		0.791**	-0.681*	0.433
Linoleic acid			-0.985**	0.136
Oleic acid				-0.025

Studying the relationship between oil content, linoleic and oleic acid with tocopherol content, Demurin (1986) determined that there is no significant correlation between these parameters.

The results of seed germination point to a great possibility of utilizing other localities for the purpose of getting high quality seed. It is obvious that Serbia, in the case of these two genotypes, is characterized as a locality that gives weak results. The results obtained showed that the influence of the environmental factors is important, even highly significant for certain observed parameters. In contrast to this statement, Balalić et al. (2006) considered that for the interaction between the hybrids and the year there is no significant difference, while in all variation sources (relation of oil content and yield, locality, year, sowing deadline and plant density) there are significant differences. Miklič (2001) concluded that the external factors do not have a great effect on oil content in the seeds, but the influence of the genotype prevails.

Seed produced in Serbia showed poorer results than the seed produced in Argentina. On the basis of given results it can be concluded that different environmental factors affect the content and chemical composition of oil in sunflower seed with certain genotypes.

In conclusion, oleic acid content was higher in seed produced in Serbia in comparison with the same seed produced in Argentina. Differences between both locations were highly significant, except for tocopherol content. Considering the great difference in seed germination, this experiment provided information about the possibility of successful seed production in other localities. Correlations were in agreement with previous results. Considering the results obtained in this research, further research should be directed towards observation of the relationships between seed germination, oil content, tocopherol content and oleic acid content in sunflower seeds.

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