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THE EFFECT OF CARBON SOURCES ON *IN VITRO* MICROTUBERIZATION OF POTATO (*Solanum tuberosum* L.)

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ABSTRACT

The effects of different concentrations (2, 4, 6, 8, 10 and 12 %) of sucrose and maltose on potato in microtuberization were evaluated *in vitro*. The highest microtuber was obtained on 4 % maltose in Agria and Justine. The highest total tuber weight was found 4 % maltose in Justine and 10 % sucrose in Justine. The optimal tuber diameter was obtained on 4 % maltose in Justine and 6 % sucrose in Agria. The best microtuberization was obtained with using sucrose in Agria and maltose in Justine. Interaction of all factors was statistically significant. It was found that the number of tuber, the weight of total tuber, the weight of single tuber and the tuber diameter were 0.0-6.25 , 0.0-0.55 g, 0.0-0.18 g, and 0.0-5.98 mm, respectively. In conclusion 6 % sucrose in Agria and 4 % maltose in Justine were suitable in microtuberization

Key words*:* Potato; microtuberization; maltose ; sucrose

INTRODUCTION

Although potato yield differs according to the environmental factors and production techniques, the main factor a effecting the yield is seed. Conventional method of vegetative propagation in potatoes are often prone to pathogens such as fungi, bacteria and viruses, thereby poor quality and yield obtains. Therefore healty potato seed should be used regeneration for every year. Consequently, much attention has been focused on the in vitro culture for production of virus-free potatoes (Karadoğan, 1994). Some searchers obtained succesful results for microtuber production of potatoes *in vitro* (Apichai, 1988; Mitten *et al.*, 1988; Karadoğan, 1999). Although production of potato microtubers *in vitro* has studied for a long time, reliable usage of this method has been slow in researche. Reasons for this delay are potato cultivar, source of explant and different nutrient media (Yıldırım & Tugay, 2002). Effects of nutrient media, hormonal factors, cultivar, temperature and light intensity etc have also been investigated. Suitable conditions were determined (Pennazio & Rudolf, 1973; Parrot, 1975; Pennazio & Vecchiati, 1976; Roest & Bokelman, 1976; Novak *et al*., 1980; Karadoğan, 1999). The purpose of this study way to determine the effect of favorable media on microtuberization of potato *in vitro*. Since microtuberization is a complex physiological process regulated by many factors among them. Adding carbon source to nutrient media is the most important factor. Therefore, the influence of sucrose and maltose concentration as carbon source on microtuberization was studied.

MATERIALS AND METHODS

In this study, potato cultivars Agria and Justine were used as plant material. Different concentrations of sucrose and maltose as carbone source were examined. The Murashige & Skoog, medium (MS) was used as initial and *in vitro* tuberization using nodal cuttings from the stock of *in vitro* plantlets. For tuberazation, coumarin (25 mg/l) was added to nutrient medium. Buds (10-25 mm length) of tubers incubated in light for 15-20 days were isolated at 1-2 mm length and cultured on MS medium, then these cultures were kept at 22-24 ^{0}C with 16h/8h day/night and in a light intensity of 954.93 lm/srm^2 for plant formation (Yıldırım & Yıldırım, 1984). Every formated plantlet was cut as made up of two nodes and subcultured in microtuberization medium included 2, 4, 6, 8, 10, 12 % sucrose and maltose and 25 mg/l coumarin (Karadoğan *et al*.,1999). Cultures were kept with 16h/8h day/night, then microtuber formations were evaluated them. Subcultures were obseved for time interval of 15 days, microtuber formation was observed and tuber number, total tuber weight (g), tuber weight (g) and tuber diameter were evaluated after 80 days.

The study was arranged in factorials with 6 replications and the analysis of variance was done using TARIST and the differences between the means were compared by LSD multiple range Steel and Torrie, 1980 software.

RESULTS

Tuber number

According the tuber number, differences between cultivars were statistically significant (P<0.01). Agria was more responsive to tuber formation than Justine. The highest microtuber number was obtained for maltose medium in both cultivars. (Figure 1).

Effects of doses differed according to carbon source. Using 40 g/l maltose, tuber number was 6.25 . However, using 40-120 g/l sucrose in medium, difference in tuber number was not statistically important (P<0.01). (Figure 2).

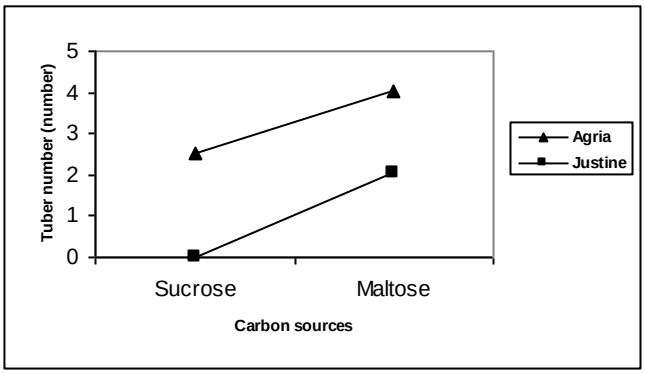

Figure 1. Effect of carbon source on tuber number of cultivars (LSD (%1): 0,40)

The highest tuber numbers were obtained from the carbon concentrations of 40 g/l both cultivars (Figure 3). Tuber formation was not found from media containing carbon for 20 g/l.

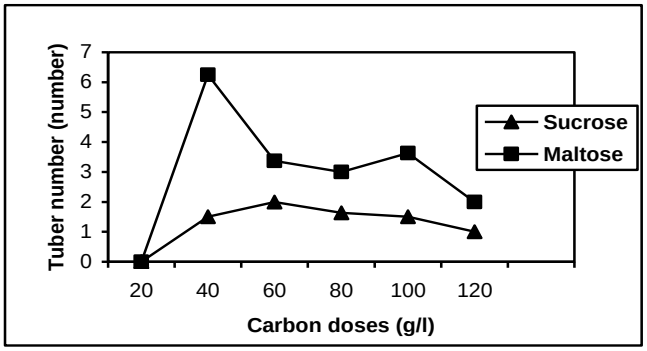

Figure 2. Effects of carbon dose on tuber number in two cultivars (LSD (%1): 0,69).

Moreover, tuber numbers according to interaction among cultivars, carbon sources and carbon doses were 8.5 in Agria and 4.0 in Justine cv. in medium including 40 g/l maltose, difference in tuber number was statistically important (LSD (%1): 1,38).

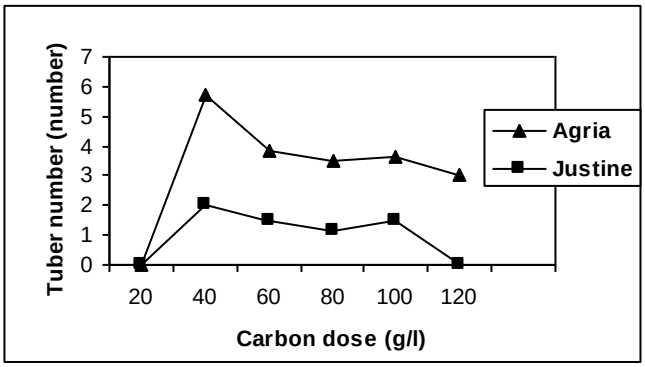

Figure 3. Effect of cultivar and carbon dose on tuber number in both carbon sources (LSD (%1): 0,95).

Total tuber yield

Total tuber yield was higher in Agria than that of in Justine cultivar. Using sucrose in Agria and maltose in Justine, the highest total tuber weight was obtained (Figure 4).

While microtuberization in the medium of 20 g/l sucrose added was low, difference among other doses for total tuber yield was not statistically significant.

When effect of doses on total tuber yield was considered, the highest total tuber yield was obtained from using sucrose (100 g/l) in Agria and maltose (40 g/l) in Justine (Figure 5).

While total tuber yield was greater in using sucrose for 100 g/l and maltose for 40 g/l in interaction of carbon sources and doses (Figure 6).

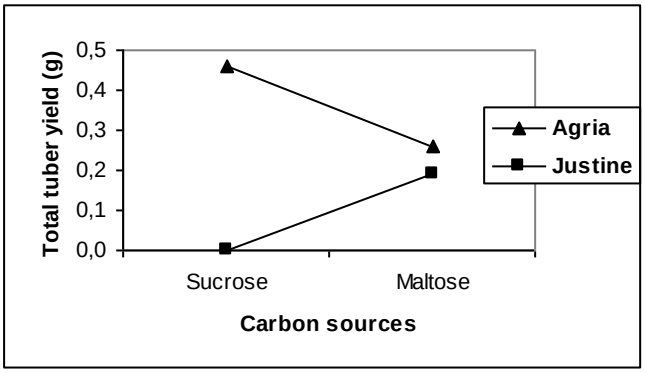

Figure 4. Effect of carbon source on total tuber yield of cultivars (LSD (%1): 0,08).

Tuber yield according to interaction among cultivars, carbon sources and carbon doses were 0,65 g in Agria in using sucrose for 100 g/l and 0,45 g in Justine cv. in medium including 40 g/l maltose, difference in tuber number was statistically important (LSD(%1): 0,57).

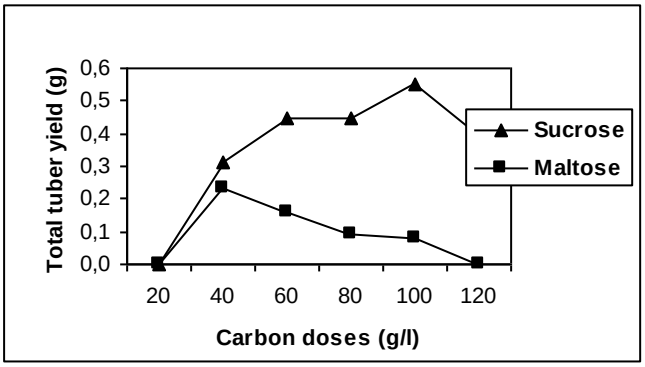

Figure 5. Effect of carbon dose on total tuber yield in two cultivars (LSD (%1): 0,13).

Tuber weight

Tuber weight was statistically significant for to carbon sources ($P<0.01$). The highest tuber weight was obtained from using sucrose in Agria and maltose in Justine (Figure 7).

When all dozes compared without considering carbon sources; tuber weight varied according to cultivars. The highest tuber weight was obtained from carbon dose of 100-120 g/l in Agria (0.18 g), and carbon dose of 40 g/l in Justine (0.07) (Figure 8).

However, difference between doses of 60-120 g/l in Agria and 40-100 g/l in Justine cv. was not statistically significant.

When the doses of sucrose and maltose were compared; the highest tuber weight (0.13 g) was obtained from sucrose added medium of 100-120 g/l and 60 gr/l maltose added (Figure 9).

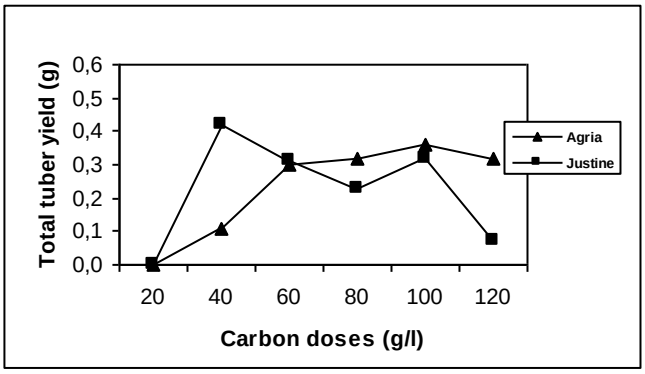

Figure 6. Effect of cultivar and carbon dose on total tuber yield in both carbon sources (LSD (%1): 0,19).

Tuber weight according to interaction among cultivars, carbon sources and carbon doses were 0,25 g in Agria in using sucrose for 100-120 g/l and 0,70 g in Justine cv. in medium including 100 g/l maltose, difference in tuber number was statistically important (LSD(%1): 0,06).

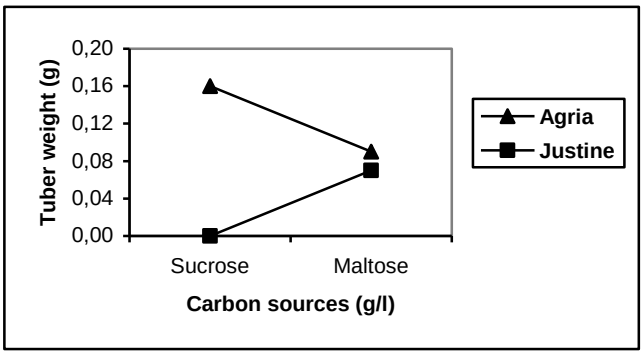

Figure 7. Effect of carbon source on tuber weight of cultivars (LSD (%1): 0,02).

Tuber diameter

Differences among the means of microtubers for cultivars were statistically significant (P<0.01). Tuber diameter was higher in Agria than that of in Justine. Carbon sources which were used tuber diameter was significantly different for carbon sources (P<0.01). The highest tuber diameter was obtained from using sucrose in Agria and maltose in Justine (Figure 10).

When the effects of doses were examined, the highest tuber diameters were obtained by using carbon sources of 100 g/l in Agria and for 40 g/l in Justine (Figure 11). But, difference between using carbon concentrations for 60-120 g/l in Agria cv. and using carbon concentrations for 40-100 g/l in Justine cv. were not significant.

The effect carbon doses of two sources on tuber diameter was statistically significant (P<0.01). The effect of high concentration of maltose on tuber size was negative and significant (P<0.01). High concentration of sucrose decreased tuber size, but the difference was not statistically significant. Microtuber formation in low concentrations of total carbon sources wasn't observed (Figure 11, 12).

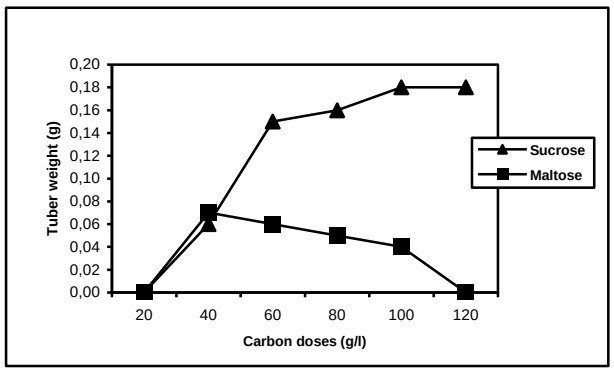

Figure 8. Effect of carbon dose on tuber weight in two cultivars (LSD (%1): 0,03).

Tuber diameter according to interaction among cultivars, carbon sources and carbon doses were 6,75 mm in Agria in using sucrose for 100 g/l and 4,11 mm in Justine cv. in medium including 40 g/l maltose, difference in tuber number was statistically important (LSD(%1): 0,82).

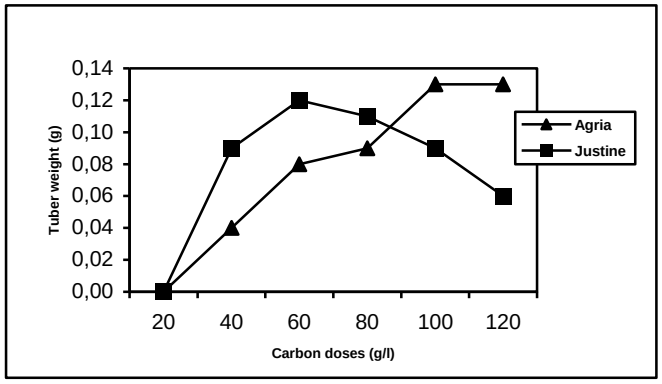

Figure 9. Effect of cultivar and carbon dose on tuber weight in both carbon sources (LSD (%1): 0,04).

DISCUSSION

According to obtained results; it could be concluded that the usage of very low and heigh carbon since concentration for optimal microtuber number and yield were unsuitable. The carbon source for tuber formation and growth in low carbon concentrations aren't enough and morever the increased osmotic concentrations of medium ruined the pH and nutrient balance in high carbon concentrations (4,2329 oz),

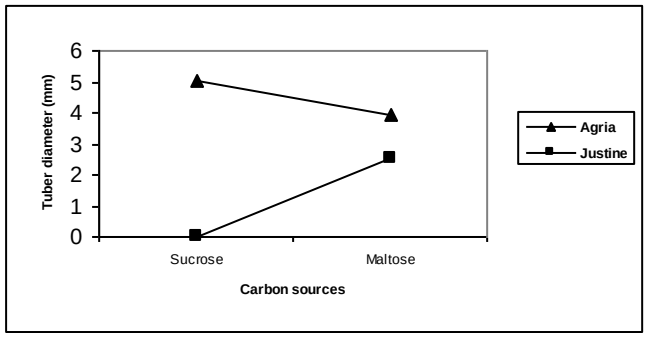

Figure 10. Effect of carbon source on tuber diameter of cultivars (LSD (%1): 0,24).

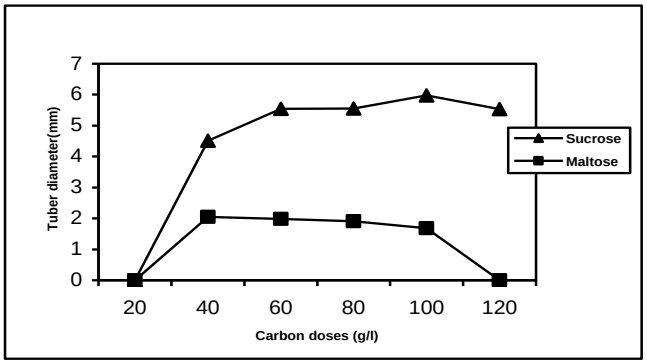

Figure 11. Effect of carbon dose on tuber diameter in two cultivars (LSD (%1): 0,41).

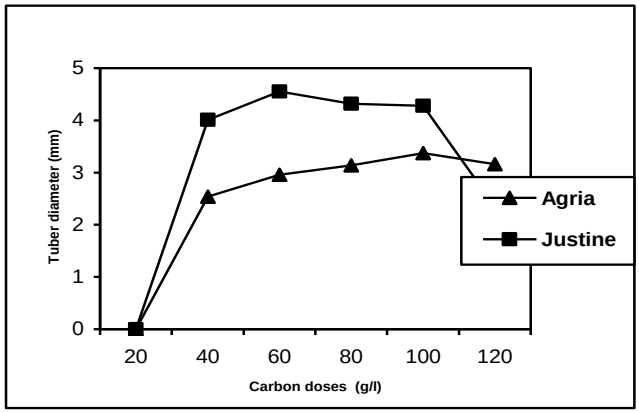

Figure 12. Effect of cultivar and carbon dose on tuber diameter in both carbon sources (LSD (%1): 0,58).

tuber formation is obstructed. Although it was reported that high carbon doses stimulated tuber formation (Welander & Pawlicki, 1994, Khuri & Moorby, 1996), possible functions of carbon sources in microtuberization were not argued. Johnson & Ryan (1990) reported that sucrose could stimulate some special genes in the potato plants but this situation was these researches not explanted. Dodds *et al.* (1992) mentioned that low and high sucrose concentrations retarded the begining of microtuberization and less microtubers obtained. The discrepancy of microtuberization among potato cultivar can be assigned to the difference in carbon sources. The reason of this, could be carbon influence of carbon sources some special genes in the potato plant (Johnson & Ryan, 1990). In the previous studies (Apichai, 1988; Karadoğan *et al.*, 1999), the tuber number and growth changed according to the cultivar which was reported.

In conclusion , the carbon sources should be investigated in accord with cultivar for production. This clearly demonstrates addition coumarin initiates microtuberization the need for 40-80 g/l of sucrose levels in the developing tuber and for a certain result, it was determined that studies need maintaining as other factors effected tuber formation consider. When we investigate results found in cultivar terms, the better results were obtained with using of sucrose (6 %) in Agria and maltose (4 %) in Justine. Microtubers should be tested for their performans in the greenhouse and in field before using commercially.

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