

Evaluation of agronomical traits and pyruvic acid content in Hamedan garlic (*Allium sativum* L.) ecotypes

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ABSTRACT

Ten garlic ecotypes collected from the main cultivation area (Hamedan) of Iran were analyzed to evaluate their agronomical traits and Pyruvic acid content. The studied characters were: plant height, leaf number, bulb weight, bulb diameter, clove number per bulb, number of bulb layers, pyruvic acid, bulb color, bulb moisture, yield, soft neck or hard neck. . We found a significant difference on bulb weight, bulb diameter, number of cloves per bulb, pyruvic acid content and bulb color. Results of yield comparison introduced superior clones that were Barfjin (12.6 t ha⁻¹), Heidare (12.4 t ha⁻¹) and Ali Abad (12.1 t ha⁻¹). Clones with more pyruvat and lowest color changes are suitable for introduction therefore based on result AliAbad, Barfjin , moein, Bahar, Heidare had more pyruvat and lowest color changes.

Key words: Garlic, Traits, Pyruvic Acid, Yield

INTRODUCTION

Garlic (*Allium Sativum* L.) is one of the most important vegetables and mostly used as a spice in the form of bulbs fresh from field or after storage [1]. The center of origin of garlic has been considered to be central Asia. Then spread Asia, Europe and in America [2]. Today global production of garlic exceeds 15,686,310 metric tons, grown 1,204,711 ha. Area under cultivation in Iran is estimated more than 10000 ha. Hamedan garlic ecotypes is most famous native garlic in Iran and also is main province of garlic production in Iran [3].

Garlic has a higher nutritive value than other bulb crops. It has hypocholesterolamic action and reduces the cholesterol concentration in human blood [4]. Varietal differences of garlic affect on yield, bulb weight, leaf length, neck diameter, bulb diameter and pungency. Garlic pungency and flavor vary according to variety and environmental conditions. Sulfur fertility and water stress may affect on garlic pungency. The hot summer temperatures prior to harvest may also increase the pungency [5]. Onion flavor is strongly influenced by the growing environment and by the time of product consumption. Therefore, the evaluation of flavor should be done under uniform growing conditions or at the time when the product is normally consumed [6].

Garlic flavor results only after tissue disruption by the rapid catabolism of S-alk(en)yl-L-cysteine sulphoxide flavor precursors by the enzyme, alliinase, to produce pyruvate, ammonia and a range of both volatile and non-volatile sulphur compounds, giving the characteristic odor and flavor of garlic(Fig.I) [7]. Pyruvate value is correlated well to the flavor compounds [8]. Characterization of the Argentine garlic cultivars by their pungency shows that after 6 months of postharvest, the most pungent cultivars reach $96.4 \pm 4.2 \mu\text{mol g}^{-1}$ pyruvate, while the content of pyruvate equal to $80.1 \pm 5.6 \mu\text{mol g}^{-1}$ shows an intermediate pungency and the least pungent cultivars have got $64.9 \pm 4.2 \mu\text{mol g}^{-1}$ pyruvate [9].pyruvate content of Iranian pink garlic clones is significantly less pungent than the white one

[10]. When bulbs are harvested 120 days after planting, their fresh mass is 50% higher than those which are gathered after 90 days of planting however, delay in harvesting shows greater pyruvate [11].

Therefore in the present study, ten Hamedan province garlic ecotypes with two check clones has been used to study their agronomic traits and pyruvic acid content as an index to evaluate pungency.

MATERIALS AND METHODS

The experiment was conducted at the Hamedan Agricultural Research Center, Iran. It was laid out on Randomized Complete block Design (RCBD) with three replications in 2008-2009. Ten garlic clones were collected from different areas of Hamedan province. The clones under test were Toiserkan, Merianej, Moein, Barfjin, Sheverin, Ali Abad, Solan, Heidare, Bahar, Toein and two check varieties, Tarom and Uromia. All cultural practices were adopted as recommended. The observation recorded during these studies were plant height, leaf number, bulb weight, bulb diameter, clove number per bulb, number of bulb layers, pyruvic acid, bulb color, bulb moisture, yield, soft neck or hard neck.

Iranian white garlic ecotypes bulbs grown in Hamedan were harvested after cut off irrigation in the mid of June. After harvesting, stems of garlic were cut 5-7 cm from the bulbs and were cured in natural condition on the net shelves with circulating the air at the temperature of 22-25 °C and the relative humidity of 45-55 percent.

Moisture content measurement: By using the air oven method the moisture content of the cloves, at 100 °C, [12] and the skins and stems of whole bulbs at 70 °C were determined.

Determination of pyruvate: The pyruvate levels in garlic cloves were analyzed according to the colorimetric procedure using a spectrophotometer based on the reaction of 2,4-dinitrophenylhydrazine (DNPH) with pyruvic acid. The pyruvate content was measured at 420 nm for both samples and standards. Standard solutions had been prepared by sodium pyruvate with concentration of 0.01 to 0.2 $\mu\text{mol ml}^{-1}$ [13].

Color measurement: Color changes measured spectrophotometry at 420 nm by 15 ml ethanol 95% and 10 ml sample after centrifuging at 3500 rpm [14].

Statistical analysis: The data collected on various parameters were analyzed statistically using analysis of variance by using SPSS software (ver.15) and Duncan's Multiple Range Test (DMRT) was used to check the differences among garlic ecotypes.

RESULTS AND DISCUSSION

In this study agronomical traits and pyruvic acid content of ten garlic ecotypes were investigated. There was non-significant difference in leaf number, clove number per bulb, plant height and number of bulb layers but bulb weight, bulb diameter, pyruvic acid content, bulb color and yield indicated significantly differences (Table I). All garlic ecotypes were soft neck and white color.

Bulb weight: The result of bulb weight (Table II) showed that garlic ecotypes differed significantly to check clones but they didn't differ significantly each other. The highest bulb weight were measured in Heidare (54.36 g) followed by merianej (52.60 g) and Solan (52.10 g). The lowest weight were observed in check clones (Uromia and Tarom).

Bulb diameter: Bulb diameter of ten garlic ecotypes didn't differ significantly each other but differ to check ecotype clones (Table I). Bulb diameter of garlic ecotypes varied from 4.55 cm (Uromia) to 5.41 cm (Merianej). The smallest bulb diameter was noted in two check clones (Table II).

Pyruvic Acid: Pyruvic acid content as an index to evaluate pungency were differed significantly (Table I). Sheverin ($84.00 \mu\text{mol g}^{-1}$) and Toein ($84.48 \mu\text{mol g}^{-1}$) had the most pyruvic acid content then followed by Ali Abad ($76.80 \mu\text{mol g}^{-1}$), Barfjin ($75.00 \mu\text{mol g}^{-1}$) and Moein ($73.20 \mu\text{mol g}^{-1}$) (Table II). An increase of pyruvic acid content shows more chief flavor component and pungency. The large amount of pyruvic acid as an indicator of and flavour has been employed by a number of researcher (Anthon and Barrete, 2003), therefore Sheverin and Toein had more pyruvic acid content and had more pungency and flavour (Fig. II).

Bulb color changes: The lowest color change obtained from Ali Abad and Moein ecotypes (0.127 and 0.129 measured at 420 nm respectively) but the highest color changes was recorded in Solan, Toiserkan, Toein and Uromia (Table I, Fig. II).

Yield: The result of yield (Table I, II) showed that garlic ecotypes differed significantly. The highest yield were measured in Heidare (12.97 ton ha⁻¹) followed by Barfjin, Ali Abad, Toiserkan, Merianej, Solan. The lowest weight were observed in check clones (5.82 and 5.60 ton ha⁻¹, Tarom and Uromia respectively).

Table I. Mean squares from the analysis of variance of agronomical traits, pyruvic acid and yield (mean 2008-2009)

Source of variation	Df	Plant height	Leaf number	Bulb weight	Bulb diameter	Mean Square					
						Clove number per bulb	Bulb layers	Pyruvic acid	Color	Bulb moisture	Yield
Replication	2	33.347 ^{**}	0.335 ^{NS}	111.59 ^{NS}	0.139 ^{NS}	0.754 ^{NS}	0.754 ^{NS}	20.287 ^{NS}	0.001 [*]	1.142 ^{NS}	0.299 ^{**}
Ecotypes	11	6.550 ^{NS}	0.215 ^{NS}	75.401 [*]	0.293 ^{**}	0.755 ^{NS}	1.111 ^{NS}	149.212 ^{**}	0.001 ^{**}	1.754 ^{NS}	0.686 ^{**}
Error	22	5.504	0.112	33.578	0.042	0.792	0.519	15.310	0.0001	2.418	0.038
C.V.(%)	-	4.24	4.44	12.23	4.00	9.56	23.22	5.50	10.18	2.43	9.40

*= significant at 0.05 probability level

**= significant at 0.01 probability level

NS=Non-significant

Table II. Comparison of the means for agronomical traits and pyruvate content

Garlic Ecotypes	Bulb weight (g)	Bulb diameter (cm)	Pyruvic Acid (μmol g ⁻¹)	Color changes (measured at 420 nm)	Yield (ton ha ⁻¹)
Solan	52.10 ab	5.38 a	69.00 def	0.174 a	10.93 ab
Toiserkan	41.48 bc	4.87 ab	67.80 ef	0.173 a	12.04 ab
Ali Abad	44.83 abc	5.07 a	76.80 bc	0.127 i	12.08 ab
Sheverin	48.43 abc	5.21 a	84.00 a	0.156 e	9.70 b
Barfjin	47.96 abc	5.31 a	75.00 bcd	0.141 f	12.25 ab
Moein	45.30 abc	5.11 a	73.20 cde	0.129 h	11.24 ab
Toein	51.14 ab	5.25 a	81.48 ab	0.164 c	10.12 b
Bahar	49.85 ab	5.26 a	68.40 def	0.135 g	10.30 b
Heidare	54.36 a	5.37 a	67.17 ef	0.140 f	12.97 a
Merianej	52.60 ab	5.41 a	66.60 efg	0.159 d	11.72 ab
Uromia	38.26 c	4.55 b	64.80 fg	0.168 b	5.60 c
Tarom	41.74 bc	4.49 b	60.00 g	0.136 g	5.82 c

Values with different letters within a column differ significantly at 5 % level of significance

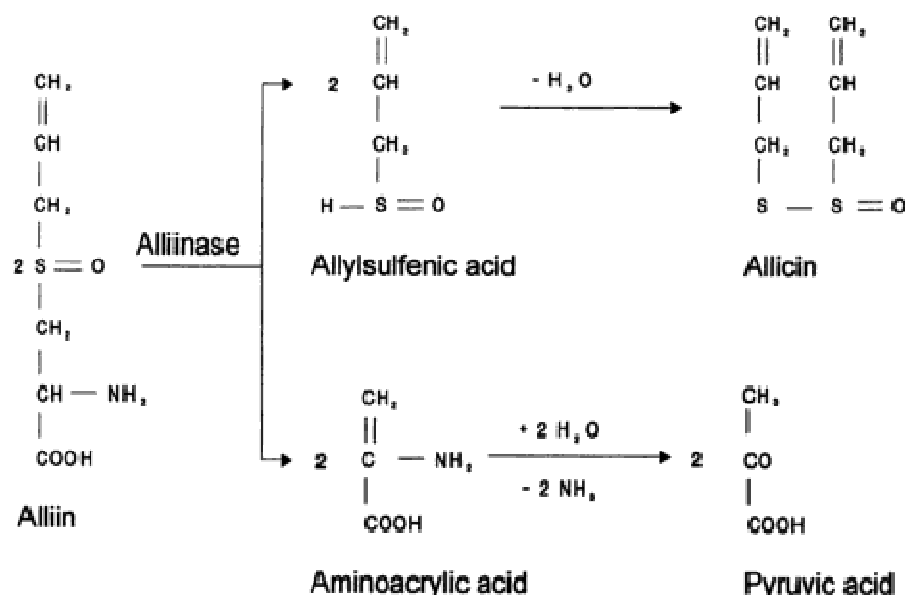


Fig I. Alliin and natural constituent of garlic, is converted by the enzyme alliinase to allicin and pyruvic acid

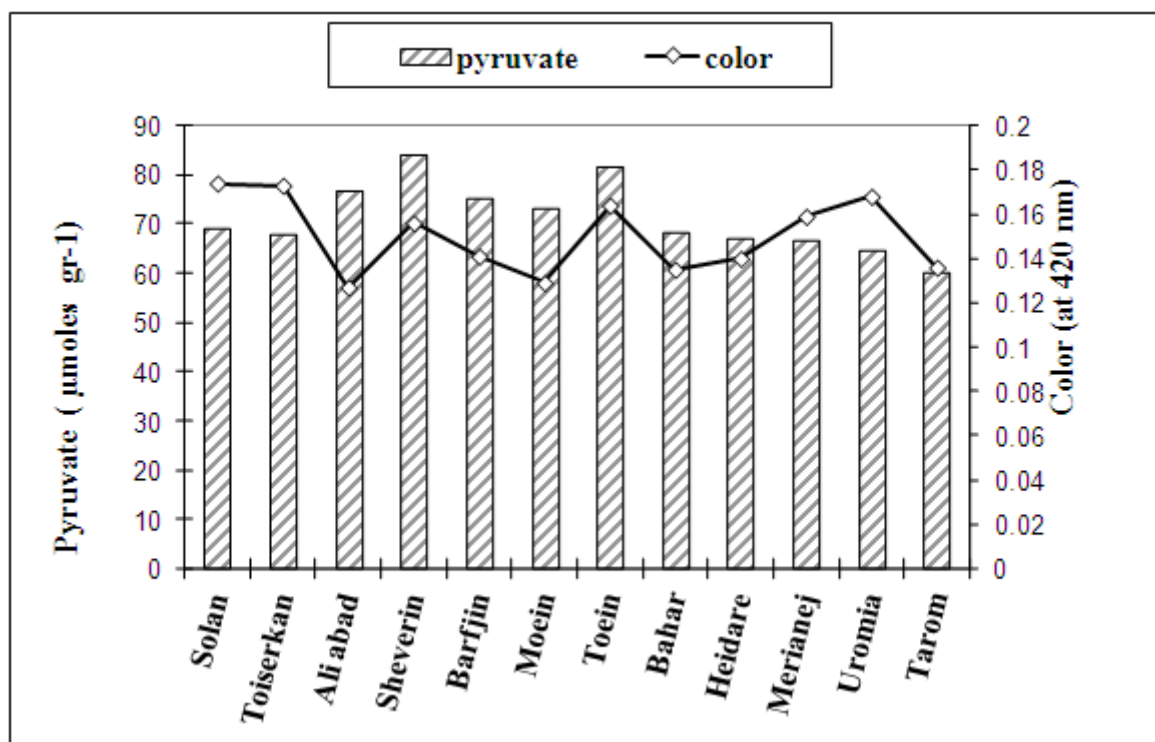


Fig.II . Color and pyruvate changes in selected and check garlic ecotypes

CONCLUSION

It can be reasonably be concluded that the results of this study showed that ten collected ecotypes didn't show large differences in agronomical traits but clones with more pyruvate and lowest color changes are suitable for introduction therefore based on result Ali Abad, Barfjin, Moein, Bahar, Heidare had more pyruvate and the lowest color changes.

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