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# **A chemical and sensorial analysis of the flavour of Irish grown organic and conventional tomatoes**

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## **Keywords**

Tomato (*Lycopersicon esculentum*, Amoroso); organic and conventional growing systems; sensory analysis; chemical analysis; principal component analysis.

## **Summary**

Tomato flavour is generally attributed to aroma factors, detected by the nose, and taste factors detected by the tongue. The aim of this study was to examine if there are differences in the flavour of Irish grown organic and conventional tomatoes (*cv Amoroso*). Three batches of organic tomatoes and three batches of conventional tomatoes were tested, using chemical and sensory analysis, each month for three months (July, August and September) during the growing season. GC-MS (n=6 each month) volatiles, pH (n=9 each month) values, and sensory analysis scores for aroma and taste (n=42 each month) were recorded. Markers of tomato aroma intensity and acceptability, overall taste acceptability, sweetness and sourness were identified in both organic and conventional tomatoes using GC-MS. Differences between organic and conventional tomatoes were recorded in each of these categories. Acidity values ranged from 4.2 +/- .04 for organic tomatoes to 4.27 +/- .07 for conventional tomatoes. A comparison between both types of tomato found no significant differences within each month for overall aroma acceptability (P>0.05). However a significant difference in taste acceptability was found within the month of August with panellists preferring the conventional tomatoes (p<.001). Panellists found the conventional tomatoes to be significantly sweeter (p<.001) within each of the three months. Application of Principal Component Analysis (PCA) showed a relationship between the chemical compounds and sensory attributes.

## **Introduction**

Organic food is derived from a production system that emphasizes the use of renewable resources and the preservation of the environment, but that avoids or largely excludes the use of synthetic fertilizers, pesticides, growth regulators and other chemicals<sup>1</sup>. Proponents of organic food claim that it is tastier than the corresponding conventional foods<sup>2</sup>. However, relevant scientific evidence to support or refute this claim is scarce<sup>3</sup>. This problem arises because very limited research has been conducted and in some cases the research was based on inadequate study designs<sup>4</sup>. The objective of this study was to compare the taste and aroma of Irish grown organic and conventional tomatoes.

## Material and Methods

Irish grown organic and conventional tomatoes (*cv. Amoroso*) harvested at the red ripe stage were selected for sensory and chemical analysis. Sensory analysis tests for taste and aroma were carried out using 14 semi-trained panelists, (9 female and 5 male). Panelists were trained according to the guidelines set out in ISO 8586-1<sup>5</sup>. Questionnaires were designed and delivered using Compusense *five* (Compusense, Guelph, Ontario, Canada). The panelists evaluated the intensity of tomato aroma, aroma acceptability, sweetness, sourness and taste acceptability of the tomatoes. An eight point scales was used for each attribute<sup>6</sup>. Instrumental tests were performed for pH and volatile compounds. The pH values of the tomatoes were determined using a pH meter (Jenway 4330) as described by Wrolstad et al.<sup>7</sup>. Headspace extractions of aroma compounds prepared by solid phase microextraction (SPME) were analysed by gas chromatography-mass spectrometry (GC-MS)<sup>8</sup>. Volatile compounds were collected using a 100µm polydimethylsiloxane solid phase micro-extraction device and analysed with a Varian 3800 gas chromatograph and a 2200 mass spectrometer. Instrumental and sensory analysis were performed in triplicate during the months of July, August and September 2006. Instrumental and sensory data was subject to ANOVA and T-Tests at the .05 significance level. LSD was used to assess the location of significant differences. The data was analysed using S.P.S.S 13 for Windows (Version1, S.P.S.S Inc, Chicago, Illinois, USA). Principal Component Analysis (PCA) was carried out to describe the relationship between both sensory attributes and chemical compounds. The program Statgraphics Plus for Windows (Version 2.1, Statistical Graphics Corporation, Rockville, MD, USA) was used.

## Results

Aroma acceptability values ranged from  $4.47 \pm 1.08$  to  $4.90 \pm 0.97$  for organic tomatoes and  $4.52 \pm 0.85$  to  $4.95 \pm 1.16$  for conventional tomatoes. A comparison between both types of tomato found no significant difference ( $P > 0.05$ ) within each month for aroma acceptability. Overall taste acceptability values ranged from  $4.34 \pm 1.44$  to  $4.60 \pm 0.81$  for organic tomatoes and  $4.72 \pm 1.37$  to  $5.18 \pm 1.06$  for conventional tomatoes. Panelists found the conventional tomatoes to be significantly sweeter ( $P < 0.001$ ) within each of the three months. Acidity values ranged from  $4.20 \pm 0.04$  to  $4.22 \pm 0.01$  for organic tomatoes and  $4.24 \pm 0.01$  to  $4.27 \pm 0.07$  for conventional tomatoes. Principal component analysis was applied to 11 odour active aroma volatiles, which had the highest detection frequencies and to the sensory attributes of sweetness, sourness, taste acceptability, intensity of tomato aroma and aroma acceptability. By applying PCA to both the sensory attributes and the odour active aroma volatiles the first two components explained 70% and 77% of the total variance for organic and conventional tomato samples respectively. For the organic PCA plots, the first principal component (PC1) contained 44.4% and the second principal component (PC2) 25.2% of variance. The aroma volatiles 2,3-dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one and 3,5-dihydroxy-2-methyl-4H-pyran-4-one were very closely associated with the intensity of tomato aroma and tomato aroma

acceptability. The aroma compounds 2-Furanmethanol, furandione, 5-methyl-2-furancarboxaldehyde and bis-phenol were found to contribute to the sensory attribute of taste acceptability. The sensory attributes of sweetness and sourness were connected with the aroma compounds N-methyl-n-nitroso-2-propanamine, 1,3-dimethyl-1H-indole and 2-Furancarboxaldehyde. For the conventional PCA plots, the first principal component (PC1) contained 51.2% and the second principal component (PC2) 25.4% of variance. The aroma compounds 2-Furanmethanol, 5-methyl-2-Furancarboxaldehyde and phenol were associated with the sensory attributes of taste acceptability and aroma acceptability. The aroma volatile 3-methyl-2,3-dihydrobenzofuran was found to contribute to the sensory attributes of sweetness, sourness and intensity of tomato aroma.

## Discussion

The results of the sensory analysis tests indicated that no significant differences ( $P > 0.05$ ) were reported for the sensory attribute aroma acceptability. However a significant difference was reported for taste acceptability with the conventional tomatoes being perceived to be sweeter than their organic counterparts. The pH of both types of tomato were similar to those reported by for organic tomatoes by Thybo<sup>9</sup> and conventional tomatoes by Tando<sup>10</sup>

Principal component analysis was conducted to explain the relationship between sensory attributes and chemical compounds. PCA is a technique which linearly transforms many variables into components which explain most of the variance in only a few components<sup>11</sup>.

## Conclusion

The results showed no significant differences ( $P > 0.05$ ) for aroma acceptability within each of the three months. However a significant difference in taste acceptability was recorded within the month of August with panellists preferring the conventional tomatoes ( $p < 0.001$ ). The sensory panel perceived the conventional tomatoes to be significantly sweeter ( $P < 0.001$ ) within each of the three months. Markers of tomato aroma intensity and acceptability, overall taste acceptability, sweetness and sourness were identified in both organic and conventional tomatoes using GC-MS. Differences between organic and conventional tomatoes were recorded in each of these categories. Application of the PCA technique provided an indication of the relationship between the odour active aroma volatiles and sensory attributes.

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