VOLATILE COMPOUNDS OF DRY BEAN SEED  
*(PHASEOLUS VULGARIS L.)*

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**ABSTRACT**

Volatile compounds of uncooked dry bean (*Phaseolus vulgaris* L.) cultivars representing 3 market classes (black, dark red kidney and pinto) grown in 2005 were isolated with headspace solid phase microextraction (HS-SPME), and analyzed with gas chromatography mass spectrometry (GC-MS). A total of 62 volatiles consisting of aromatic hydrocarbons, aldehydes, alkanes, alcohols and ketones represented on average 62, 38, 21, 12, and 9 x 10^6 total area counts, respectively. Bean cultivars differed in abundance and profile of volatiles. The combination of 18 compounds comprising a common profile explained 79% of the variance among cultivars based on principal component analysis (PCA). The SPME technique proved to be a rapid and effective method for routine evaluation of dry bean volatile profile.

**INTRODUCTION**

The low Canadian per capita dry bean consumption at 2.5 kg per annum in 2005 [1], may be due to the unsophisticated taste and flavor consumers generally associate with dry bean products despite their nutritional and health benefits. Flavor, an important factor in overall acceptability, and cooking time were two main characteristics used by consumers to select a given type of bean according to a survey conducted in Mexico [2, 3]. Flavor is most often ascertained on cooked or canned bean. Presently, flavor of canned bean is judged subjectively for flat, dull, bitterness, acid, sweet and off-flavor by a trained and experienced sensory evaluation team with scores ranging between 2.4 to 3.2 (2=fair, 3=good and 4=very good). Studies of flavor in dry bean [4, 5, 6] were preceded by identification of about 90 volatile components of canned whole bean [7].

SPME is a simple, sensitive, robust, reliable, low cost and very popular fast screening sampling technique based on analyte diffusion that combines the advantages of both static and dynamic head space for qualitative volatile analysis [8]. Information currently available on the volatile components of dry beans is deficient and full investigations of the uncooked beans are long overdue. In the present study, HS-SPME was applied as a solvent-free sample preparation method, with GC-MS analysis, to provide the initial investigation of the volatile profile of dry bean from Manitoba. This is the first step in unraveling and elucidating bean volatiles as a prerequisite in developing new cultivars for increased economic value and novel bean ingredients for health and functional food uses.

**MATERIALS AND METHODS**

Black bean cultivar AC Harblack, CDC Rio and Onyx; pinto bean cultivar AC Pintoba and Maverick; and dark red kidney cultivar ROG 802 and Red Hawk grown in 2005 in southern Manitoba were used in this study. The bean seeds were stored in a dry room (23°C, 15-20% relative humidity) prior to analysis.

Ten grams of freshly ground dry bean seed sample was used to extract volatiles using SPME. Grinding and collection of headspace volatiles were performed in triplicate from the same lot for each sample. After extraction, the analytes were thermally desorbed at 250°C for 2 min in the injection port of an Agilent 6890/5973 GC-MS and separated on a Supelcowax 10 polar column, 60 m x 0.25mm with a 0.50 μm film thickness. Data were collected with Agilent enhanced ChemStation.
software (standard MSD version) and searched against the NIST (v. 02) and Wiley (v. 138) libraries (Palisade Corp., Newfield, NY). Compounds were identified by preliminarily library search, and identities were confirmed by comparison of their GC retention time with eight internal standard solutions of C7-C22 n-alkanes and MS ion spectra. Levels of flavour components were determined from the average of three replicate chromatograms, calculated and expressed as the area units of their abundance (total area counts, TAC).

Data were subjected to analysis of variance by the general linear models (GLM) procedure, means comparison by Duncan’s test, and Principal component analysis according to Statistical Analysis System [9].

RESULTS AND DISCUSSION
A total of 62 headspace volatile compounds isolated by SPME were tentatively identified in dry bean seeds by GC-MS. Cultivars differed in relative abundance of extracted volatiles with low (< 70 x 10^6 TAC) (black bean AC Harblack and dark red kidney ROG 802), intermediate (115 x 10^6) (Red Hawk) and high (> 190 x 10^6) (AC Pintoba, CDC Rio, Maverick and Onyx) abundance. The volatile profile of AC Harblack and ROG 802 consisted of only 32 and 25 compounds, respectively, and in addition had the lowest content of 13 compounds. The low volatile compounds detected in AC Harblack and ROG 802 probably indicates suppression of their lipoxygenase enzyme, particularly the lipoxygenase 3 enzyme involved in aroma biosynthesis [10].

The volatile classes included 14 alkanes (4.6 to 42.6 x 10^6 TAC for AC Harblack and AC Pintoba, respectively), 11 aldehydes (14.4 to 55.8 x 10^6) and 10 aromatic hydrocarbons (29.1 to 83.4 x 10^6 for AC Harblack and Onyx, respectively), 10 alcohols (3.6 to 19.3 x 10^6 for AC Harblack and AC Pintoba, respectively), 7 ketones (4.3 to 12.7 x 10^6 for ROG 802 and CDC Rio, respectively), 3 terpenes (0.8 to 14.7 x 10^6) and 2 furans (0.4 to 2.7 x 10^6 for AC Harblack and AC Pintoba, respectively). The aromatic hydrocarbons, aldehydes, alkanes, alcohols and ketones represented 62.2 ± 23.7, 37.8 ± 16.4, 21.1 ± 15.2, 11.5 ± 6.5 and 8.8 ± 3.6 x 10^6 TAC, respectively. The SPME method for profiling bean headspace volatiles may be acceptable as a first step for segregating bean types and later can be applied in genetic improvement of flavor in dry bean. Basic knowledge of volatile compounds constituting the unique dry bean flavor can facilitate better quality control of raw materials and also help product developers meet flavor-delivery challenges.

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REFERENCES