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수집 조 종자의 지방산 조성

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Fatty Acids Composition of Foxtail millet (*Setaria italica* BEAUVOIS) Seeds Collected in South Korea

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ABSTRACT : Some fatty acids(palmitic acid, stearic acid, oleic acid, linoleic acid and linolenic acid) in foxtail millet seeds were evaluated. In this study, 32 varieties of accession collected from different place of South Korea were used in order to evaluate their fatty acid composition and concentration. These samples were analyzed by GC with HP20 column. Significant variability in individual fatty acids was observed. The palmitic acid ranged from 10.9 to 13.5%, stearic acid from 2.5 to 8.3%, oleic acid from 10.0 to 15.8%, linoleic acid from 62.5 to 67.9% and linolenic acid ranged from 3.0 to 5.2%. This variability can be exploited for selection of plant and for studying the genetic variability in millet. These selections can also be utilized for genetic improvement of the crops.

Key Words **:** Fatty Acid, Gas Chromatographic, Foxtail Millet, Seeds

INTRODUCTION

Fatty acid include saturated and unsaturated acid and It depends on the presence of unsaturated double bond in the fatty acid chain (De Geus *et al.,* 2001). Different Double bond at different place is named different acids. Essential fatty acids are polyunsaturated fatty acid. Linoleic acid (C18:2) and a-linolenic acid (C18:3) are the parent compounds of the mega-6(ω-6) and omega-3(ω-3) fatty acid series, respectively (De Geus *et al.,* 2001). They are very important for human health, because they cannot be synthesized inside the body. The essential fatty acids are very important to human immune system to help regulate blood pressure. Linolenic acid and linoleic acid are found in some foods such as fish, shellfish flaxseed (linn seed), soya oil, canola (rapeseed) oil, hemp oil, chia seed, pumkin seed, sunflower seed, cotton seed oil, leafy vegetables and walnut. The importance of fatty acid analysis has gained much attention because of the nutritional and health implications. The most common procedure for the analysis is the conversion of fatty acid components to methylester in order to improve their volatility. Essential fatty acids are verified to prevent coronary heart disease, hypertension, type 2 diabetes, and in some patients with renal disease, rheumatoid arthritis, ulcerative colitis crohn's disease, and chronic obstructive pulmonary disease (Simopoulos, 1991).

There are many papers focusing the analysis of fatty acid in plant seed such as flaxseed (Degenhardt *et al*., 2002), grape seed oil (Cao And Ito, 2003), Thai Durian aril (Phutdhawong, 2005), Australian purlane (Liu *et al*, 2000), Calodendrum capense thumb (Munavu, 1983), rapeseed(Daun and Mazur, 1983), Tamaridus indica L. (Andriamanantena, *et al*., 1982), and China chestnut (Berry, 1982).

Therefore, the objective of this research is to evaluate the composition of palmitic acid, stearic acid, linoleic acid, a-linolenic acid and oleic acid in foxtail millet seeds.

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MATERIALS AND METHODS

1. Sample and chemicals

Fatty acids analyzed from foxtail millet seeds by the Gas Chromatographic (model and made in country). The seeds stored at 4-5℃ refrigerator before the experiment. Chemicals of chloroform methanol Petroleum Ether Toluene NaCl NaOH and 14% BF_3 in methanol were used for analysis. Reagent grade for GC (Mallinck rodt Baker. Lnc.phillopsbur. NJ 08865 USA) and pentadcanoic acids ordered from SIGMA chemical (CO.P.O. Box st. louis, Mo 63178 USA) used as an internal standard.

2. Internal standard

The Internal standard solution was prepared by dissolving 100 ㎎ in 100 ㎖ of methanol.

3. Sample protocol

The sample flour of 0.2 g is weighed in a 50 ㎖ conical centrifuge tube and mixed with 5 ㎖ solvent [chloroform : methanol = 1 : 1(v/v)] and Internal standard 1 ㎖. It is then vortex-mixed for 10s and sonication 60 mins and mixed with 5 ㎖ 0.5% NaCl solution. After vortex-mixed sonication of 10min., centrifuged for 15 min. Allowed to reach a speed of 2000 rpm and temperature 4℃ and then stopped immediately. Great care was taken during this transfer to avoid the lower layer. After collecting the down tier liquid cover the conical centrifuge tube with foil and shaked by hand lightly. Dried under a stream of nitrogen (shake speed 250 rpm and temperature 45℃) in a pume hood. 0.5 ㎖ toluene and 2 ㎖ 0.5 N NaOH added in methanol solution vortex-mixed and heated for 5 min at 85℃. After cooling in hume hood, 2 ㎖ of BF_3 are added and then Vortex-mixed and heated for 5 min at 85℃. The mixture is cooled and subsequent portions of 10 ㎖ petroleum ether and 10 ㎖ of water added. vortex-mixed for 15s by hand was heavily placed in a centrifuge allowed to reach a speed of 2000 rpm and make sure temperature 4℃ after 10min and then stopped immediately. After collecting up tier liquid, we used filter paper and Sodium sulfide (Na_2SO_4) and made sure that there is no water in the liquid. Dried the liquid under a stream of nitrogen in the hume hood. 1 ㎖ of petroleum ether added in the glass tube, collected all the liquid and put them in cap vial and submitted to GC analysis.

Table 1. Percentage (%)of saturated fatty acids analyzed by GC.

Varieties	Concentration (%)		Total SFA*
	Palmitic acid	Stearic acid	
Oljo	11.5±0.01	7.4±0.08**	18.8
Geurujo (Maejo)	11.0±0.79	7.7±0.11	18.7
Geurujo (Kwangju)	11.2±0.56	6.7±0.89	17.8
Wonju 7ho	11.1±0.36	6.6±1.33	17.7
Maejo	10.9±0.23	7.5±0.59	18.4
Jejujo	12.7±0.22	2.6±0.98	15.3
Hongcheon	12.1±0.65	5.9±0.56	18.0
Ilbanmaejo	13.7±0.98	6.4±0.32	20.2
Nuetjo	13.2±0.23	7.0±0.88	20.2
Hwanggeummaejo	11.8±0.09	7.2±0.36	19.0
Olhwangchajo	12.0±0.65	7.2±0.87	19.1
Mongdangjo	12.8±0.22	6.7±0.56	19.5
Hwangchajo	11.9±0.13	7.1±0.65	19.0
Kojangjo	13.2±0.35	7.6±0.13	20.8
Rijo	13.3±0.87	7.6±0.87	20.9
Hwangchajo (Jinju)	12.7±0.83	6.2±0.39	19.0
Bookshimichajo	14.1±0.45	6.9±0.56	21.0
Sanchongjo	12.6±0.19	4.4±0.17	17.0
Ganghwajo	13.1±0.53	7.7±0.53	20.8
Jangsuhwangchajo	12.4±0.33	5.6±0.37	18.0
Noranchajo	13.5±0.16	6.2±0.29	19.7
Bookseulhwangchajo	12.5±0.62	7.0±0.99	19.5
Areunchajo	13.0±0.32	6.2±1.09	19.2
Gaebalchajo	12.6±0.38	6.2±0.72	18.8
Wonju 56ho	13.5±1.09	5.8±0.56	19.3
Paranchajo (cholwon)	12.3±0.55	2.5±0.05	14.8
Chongsalmichajo	12.0±0.69	6.1±0.62	18.1
Chongchajo	13.0±0.78	5.6±0.18	18.6
Chongchajo (RDA)	12.4±0.61	2.6±0.96	15.0
Chajo	12.8±1.12	6.6±0.55	19.4
Eunchajo	12.3±0.79	6.0±0.43	18.3
Hinchajo	13.4±0.17	8.3±0.73	21.6

*SFA: saturated fatty acid
**Values represent the average of three replicates±standard deviation (SD).

RESULTS

The comparison of saturated and unsaturated fatty acids from millet seeds (Tables 1 and 2) by GC are given in this section. We analyzed five fatty acids in the foxtail millet seeds. They are palmitic acid, stearic acid, oleic acid, linoleic acid and linolenic acid. All of the accessions contain oleic acid, linoleic acid and linolenic acid as a major unsaturated fatty acids when analyzed by GC (Fig. 1). Total amount of unsaturated fatty acids in foxtail millet

Table 2. Percentage*(%)of unsaturated fatty acids analyzed by GC.

Varieties	Concentration (%)				Total
	Oleric acid	Linoleic acid	Linolenic acid	Total	PUFA*
Oljo	12.5±0.13	65.4±1.09	3.2±0.62**	81.2	68.6
Geurujo (Maejo)	12.8±0.09	65.4±1.29	3.0±0.31	81.3	68.4
Geurujo (Kwangju)	11.6±0.06	66.8±0.25	3.8±0.29	82.2	70.6
Wonju 7ho	12.3±0.02	66.5±0.24	3.6±0.49	82.3	70.0
Maejo	13.1±0.15	65.4±0.98	3.1±0.37	81.6	68.5
Jejujo	15.8±0.32	65.0±0.27	3.9±0.09	84.7	68.9
Hongcheon	11.9±0.52	65.5±0.39	4.7±0.35	82.0	70.2
Ilbanmaejo	10.5±0.23	65.0±1.06	4.3±0.13	79.8	69.3
Nuetjo	11.4±0.66	64.1±1.98	4.4±0.64	79.8	68.5
Hwanggeummaejo	12.7±0.25	65.1±0.87	3.3±0.28	81.0	68.4
Olhwangchajo	12.1±0.42	65.3±0.56	3.4±0.34	80.9	68.7
Mongdangjo	13.0±0.03	63.9±1.12	3.6±0.29	80.5	67.5
Hwangchajo	13.2±0.06	64.5±1.65	3.2±0.37	81.0	67.7
Kojangjo	10.8±0.58	64.4±0.76	4.1±0.29	79.2	68.4
Rijo	10.9±0.64	64.0±0.36	4.2±0.13	79.1	68.2
Hwangchajo (Jinju)	11.3±1.09	65.7±0.85	4.1±0.03	81.0	69.8
Bookshimichajo	10.1±0.65	63.6±0.34	5.2±0.54	79.0	68.9
Sanchongjo	13.8±0.24	65.2±0.54	4.0±0.31	83.0	69.1
Ganghwajo	10.3±0.32	64.8±0.65	4.1±0.95	79.2	68.9
Jangsuhwangchajo	10.8±0.91	66.5±0.29	4.8±0.16	82.0	71.2
Noranchajo	10.6±0.23	65.1±0.34	4.6±0.64	80.3	69.7
Bookseulhwangchajo	11.0±0.33	65.1±0.26	4.4±0.29	80.5	69.5
Areunchajo	10.0±0.85	66.0±0.57	4.8±0.16	80.8	70.7
Gaebalchajo	11.4±0.32	65.0±0.64	4.8±0.34	81.2	69.8
Wonju 56ho	10.5±1.23	65.5±0.39	4.7±0.13	80.7	70.2
Paranchajo (cholwon)	13.7±0.26	67.9±0.27	3.6±0.28	85.2	71.5
Chongsalmichajo	10.5±0.39	67.9±0.97	3.5±0.64	81.9	71.4
Chongchajo	11.1±0.21	66.2±0.69	4.0±0.19	81.4	70.3
Chongchajo (RDA)	14.1±0.35	67.6±0.65	3.3±0.13	85.0	70.9
Chajo	12.3±0.43	63.8±1.29	4.4±0.54	80.6	68.2
Eunchajo	12.3±0.36	65.3±0.68	4.1±0.19	81.7	69.3
Hinchajo	12.0±0.46	62.5±0.99	3.8±0.69	78.4	66.3

*PUFA: polyunsaturated fatty acid.
**Values represent the average of three replicates±standard.

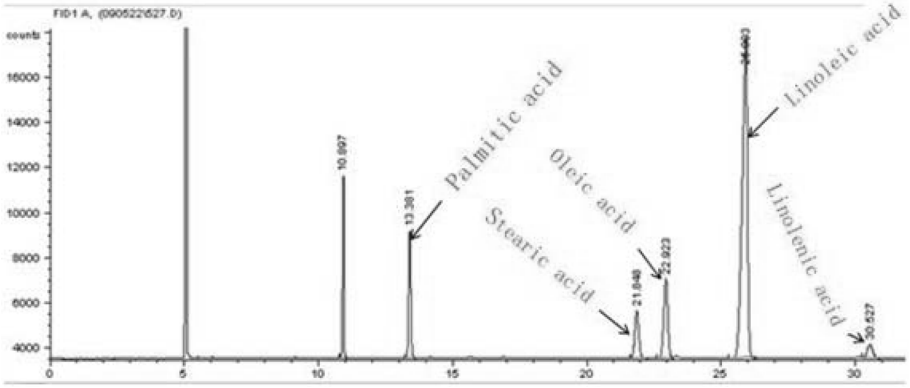

Fig. 1. Chromatogram of fatty acid free from different foxtail millet seeds by HP-20 capillary column (50 m*0.2 ㎜ I.d.).

seeds varies from 78.4% in foxtail millet of 32 to 85.2% in foxtail millet of 26. All of the varieties PUFAs were higher than oleric acids. The content of linoleic acid in the seed was higher than other fatty acids. Among the fatty acids in 32 accessions, content of palmitic acid ranged from 10.9% to 13.5%, stearic acid from 2.5% to 8.3%, oleic acid from 10.0% to 15.8%, linoleic acid from 62.5% to 67.9% and linolenic acid ranged from 3.0% to 5.2%. These results suggested that the foxtail millet seed may serve as a potential dietary source of MUFA.

DICUSSION

Foxtail millet accessions also contains two saturated fatty acids, palmitic acid and stearic acid (Table 1). In all foxtail millet varieties investigated, palmitic acids was present in higher percentage among the saturated fatty acids. There is no variation in stearic acid in their concentration among all the varieties studied.

It is concluded that fatty acids obtained from different accessions of foxtail millet could be alternative source of edible oil due to presence of all saturated and unsaturated fatty acids required for human health. This is the study on the fatty acid compositions of millet accessions and it is expected that further studies on the quality aspects of foxtail millet accessions and this will highlight its future ranking as a food. It is also important for seed resource development.

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