CONJUGATED LINOLEIC ACID PRODUCTION BY *L. PLANTARUM* AB20-961 AND *L. PLANTARUM* DSM2601 IN FERMENTED SAUSAGE

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Abstract – The utilization of *L. plantarum* AB20-961 and *L. plantarum* DSM2601 in sausage fermentation was investigated to enhance conjugated linoleic acid (CLA) contents in fermented meat products. CLA-producing abilities of these bacterial strains and optimum fermentation time and temperature, the initial count of added strains, the type and amount of added fatty acid source conditions in meat model system for enhanced CLA production by these strains were determined previously. Optimum conditions applied for sausage manufacture were: 5% safflower oil, 8 log cfu/g initial count for both added strains, and 78.78 h fermentation time for *L. plantarum* AB20-961 and 72.57 h for *L. plantarum* DSM2601 at 24 °C. Two control sausages were also produced under the same fermentation conditions without *L. plantarum* strains and safflower oil. Chemical composition (CLA content, fatty acid and proximate compositions), physicochemical properties (pH, TBARS, color) and microbiological properties of sausages were determined. Study results indicated that both strains were able to produce CLA isomers in sausage. The amount of CLA in sausage was increased 21% by *L. plantarum* AB20-961 and 121% by *L. plantarum* DSM2601 after fermentation period compared to initial CLA level determined on manufacturing day ($P<0.05$). CLA content did not alter during the storage.

Key Words – conjugated linoleic acid, microbial production, sausage fermentation.

I. INTRODUCTION

Many studies showed that several food grade bacteria such as lactobacilli, bifidobacteria and propionibacteria can form CLA isomers from linoleic acid (LA) *in vitro* and furthermore, some researcher stated that potential CLA producing microorganisms may be used as starter cultures to increase levels of CLA isomers in food (Ogawa et al., 2005; Leroy, Verluyten, & De Vuyst, 2006; Gorissen, Raes, De Smet, De Vuyst, & Leroy, 2012). However, there is limited information about enhancing the amounts of CLA in a meat system by fermentation (Gorissen et al., 2012; Ozer, Kilic, & Kilic, 2016). The purpose of this study was to enrichment of CLA content in sausage via fermentation by *L. plantarum* AB20-961 and *L. plantarum* DSM2061, which showed the ability to produce CLA *in vitro* and in the meat model system.

II. MATERIALS AND METHODS

L. plantarum DSM2601 was selected from the catalogue of DSMZ (Deutsche Sammlung von Mikroorganismen und Zellkulturen GmbH, Braunschweig, Germany) and *L. plantarum* AB20-961 was isolated from human sources in Suleyman Demirel University (Turkey) and its probiotic properties were determined previously (Kılıç & Karahan, 2010). Safflower oil were hydrolyzed by the method of (Senanayake & Shahidi, 1999) before used. Sausage manufacture, total lipid extraction and fatty acid analysis were performed as described by Ozer et al. (2016). Experimental design and fermentation conditions for enhanced CLA production by both *L. plantarum* strains used in this study were determined according to the results of our previous optimization experiment (Unpublished data) in the meat model system. The experimental design is shown in table 1. After the fermentation process, sausages were cooked to 65 °C internal end point temperature. The experimental design for statistical purposes was completely randomized design with 4 treatment groups and 3 replications. The statistical evaluation of the results was performed using the SPSS 22.0.0 (SPSS Inc., Chicago, USA). The treatments were two control (no *L. plantarum* strain and fatty acid source) and two groups with *L. plantarum* AB20-961 or *L. plantarum* DSM2601. Data collected for chemical composition (CLA content, fatty acid composition, proximate composition), physicochemical properties (pH, TBARS and color values) and microbiological properties of

sausages were analyzed by one-way analysis of variance (ANOVA). Differences among mean values were established using the Duncan multiple range test and considered significant when $P<0.05$.

Table 1. Experimental design and fermentation conditions for sausage production

Groups	Added *L. plantarum* strain	Initial count of *L. plantarum* (cfu/g)	The amount of added fatty acid source (%)	Fermentation time (h)	Temperature & Moisture
Control 1	-	-	-	78.78	24 °C – 90%
Control 2	-	-	-	72.57	24 °C – 90%
Group 1	*L. plantarum* AB20-961	10^8	5	78.78	24 °C – 90%
Group 2	*L. plantarum* DSM2601	10^8	5	72.57	24 °C – 90%

III. RESULTS AND DISCUSSION

Results showed that CLA content in sausage significantly increased via fermentation by both *L. plantarum* strains ($P<0.05$). While the CLA content of sausage dough was 3.41 mg CLA/g fat, after the fermentation process, CLA content of the sausages produced with *L. plantarum* AB20-961 or *L. plantarum* DSM2601 were 4.15 mg CLA/g fat and 7.54 mg CLA/g fat, respectively.

The results indicated that protein, ash and color values of sausage samples showed non-significant differences among treatment groups. However, control groups had higher pH and moisture, and lower fat values compared to sausages manufactured with *L. plantarum* AB20-961 or *L. plantarum* DSM2601 ($P<0.05$). TBARS results indicated that the sausages manufactured with *L. plantarum* AB20-961 or *L. plantarum* DSM2601 had higher ($P<0.05$) TBARS than those of control counterparts after fermentation, cooking and storage periods. Mould, yeast and coliform bacteria count results showed non-significant differences among treatments after fermentation. However, sausages manufactured with *L. plantarum* AB20-961 or *L. plantarum* DSM2601 had higher *L. plantarum*, lactic acid bacteria and mesophilic aerobic bacteria count after fermentation compared to both control sausage groups ($P<0.05$).

IV. CONCLUSION

This study concluded that CLA content of fermented sausages may be enriched by *L. plantarum* AB20-961 or *L. plantarum* DSM2601 with optimized fermentation conditions.

ACKNOWLEDGEMENTS

The authors would like to thank the Scientific Research Projects Coordinatorship of Suleyman Demirel Universty for the financial support of this project (Project No: OYP05440-DR-12).

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