延长豆浆保质期工艺条件的优化

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摘 要:豆浆营养物质含量丰富,深受人们的青睐,但极易受到微生物的污染,使其保质期缩短。分别从大豆原料、模拟管道、豆浆产品三方面进行控制,确定了大豆原料、模拟管道、豆浆产品最优的杀菌方式:大豆原料采用传统的100℃水浴巴氏杀菌10 min;模拟管道用有效氯浓度(ACC)为(17±0.5)mg·L^{-1}的酸性电解水清洗;豆浆产品在100℃条件下杀菌5 min,并添加0.15 g·kg^{-1}乳酸链球菌素(Nisin)。在上述条件下,豆浆产品中所有细菌全部被杀死或杀伤,25℃保藏条件下保质期为4 d。同时初步鉴定出大豆原料及豆浆中最难致死细菌(S)为蜡样芽孢杆菌(*Bacillus cereus*)。

关键词:大豆原料;模拟管道;豆浆;杀菌;细菌鉴定;保质期

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Optimization of Technological Condition on Shelf-life of Soybean Milk

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Abstract: Soybean milk is one of the favourite drinks in China. However, it is vulnerable to microbial pollution extremely for its rich nutrition, which leads to short shelf-life. To solve this problem, this paper considered different combinations of soybean raw materials, simulative pipelines and sterilization methods for finished soybean milk. The results showed the best sterilization way: First of all, soybean raw materials adopted traditional 100℃ water-bath pasteurizing to sterilize for 10 min; Secondly, simulative pipeline was washed by acidic electrolysis of water with the concentration of available chlorine (ACC) at (17±0.5) mg·L^{-1}; Thirdly, the sterilization temperature, sterilization time and additive amount of Nisin was controlled at 100℃, 5 min and 0.15 g·kg^{-1}, respectively. Through above sterilization way, all the bacterias in the soybean milk were killed or damaged, ensuring 4 d shelf-life under the condition of 25℃. Besides, we also preliminary identified the toughest bacteria (S) to kill both in the soybeans and soybean milk was *Bacillus cereus* strain.

Key words: Soybean raw materials; Simulative pipeline; Soybean milk; Sterilization; Identification of bacteria; Shelf-life

豆浆是一种以大豆为主要原料制成的植物蛋白饮品。长期以来,豆浆作为优质蛋白质的重要来源受到人们的青睐[1]。但正是由于营养物质含量丰富,豆浆成为了微生物优良的培养基,极易受到微生物的污染,保质期非常短,目前市售的鲜豆浆夏天常温下保质期一般都达不到1 d,即使4℃条件下保藏,保质期也只有2~3 d;尽管高温高压杀菌能使保质期达到30 d,但因杀菌温度过高对豆浆的营养物质破坏很严重,传统的水浴巴氏杀菌时间较长,同样会破坏豆浆的营养成分[2]。为了达到较好的杀菌效果,延长豆浆保质期,该试验从大豆原料、模拟管道、豆浆产品三方面进行了处理,其中在对豆浆进行传统水浴巴氏杀菌的同时,向豆浆中添加了天然防腐剂乳酸链球菌素(Nisin)以期得到保质期较好的豆浆,同时还对大豆原料及豆浆中最难致死的细菌类型进行了初步鉴定。

1 材料与方法

1.1 供试材料

大豆原料,市售东北小圆豆;乳酸链球菌素(Nisin),郑州天华食品添加剂有限公司;培养基,平板计数琼脂培养基(PCA);细菌基因组DNA提取试剂盒,天根生化科技有限公司;通用型PCR试剂盒,天根生化科技有限公司。

1.2 仪器与设备

SL-380型搅拌机,上海国生实业有限公司;PL202-L电子天平,梅特勒·托利多仪器(上海)有限公司;电热鼓风干燥箱,重庆银河试验仪器有限

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通讯作者:汪立平(1968-),女,副教授,主要从事食品科学与食品工程研究。E-mail:lpwang@shou.edu.cn。

Ú Ÿ ô÷ äæÐ Ï k á ª ú B ü å½ à w á ( ) Ý š ¹ F Ú Ÿ ô÷ Šâ Š Ð ª ý / ƒ š å? O ® Û ô ÿ÷ Šö÷ Š Ð ü ú …Ï k á ª ' ¶ j å½ à ¿ € â þ š ¡ ÿ ô ûóåãŠæâÐ ‹ …¸ Å ü å½ à – ª —š ÿ ô ÷ Šâæ g ˆ å $ ñ Ú Ÿ ô› Ç = / È å½ à L f i Ö × (S ¹ F Ú Ÿ ôÿò Ý å Ð] û (S ô õ ŠâÐ 3 ¨ ¯ Ï H ú ˜ º š áÄ ® ± ˜ 6 äû¨ ¯ Ï H ú T äûÆ¯ Ï H ú âåû † ðüðýþ Ú Ÿ ô ÷ áþ ÿ“ WÝ åþ i ú ëû $ o Ý š á½ à å F Ú Ÿ ô òŠõÐ » Ž À ¹ O Ã “ WÝ á‘ · ž > óâ†ååâ ë ûßã ảf D < óã ë ûßãâåû † ê

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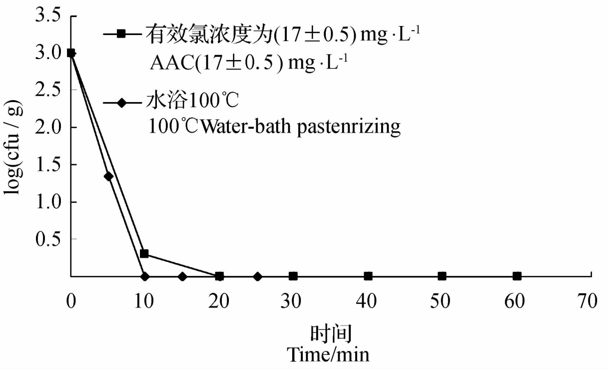

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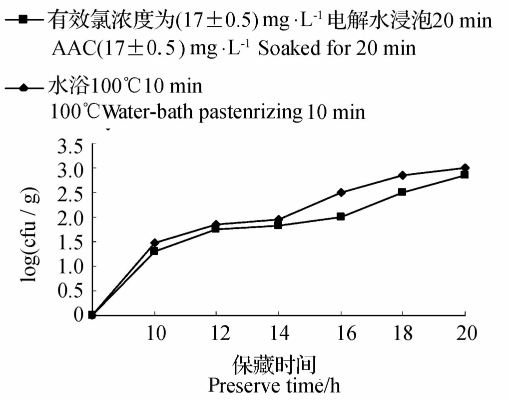

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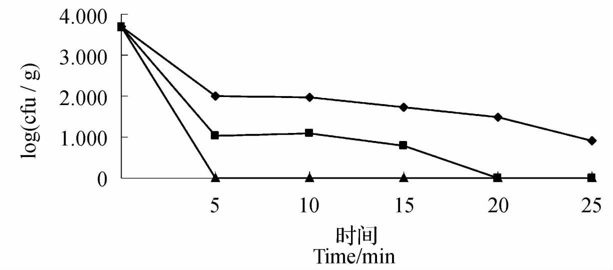

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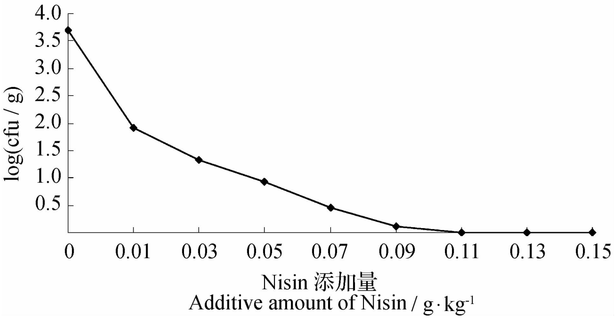

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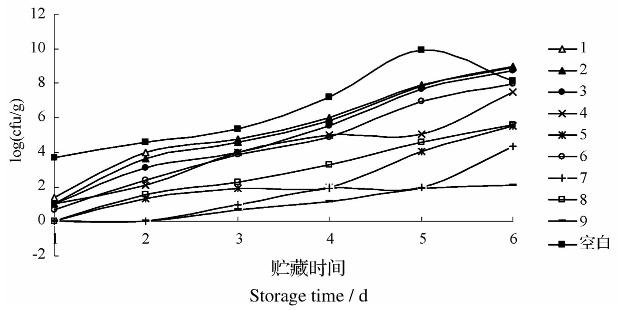

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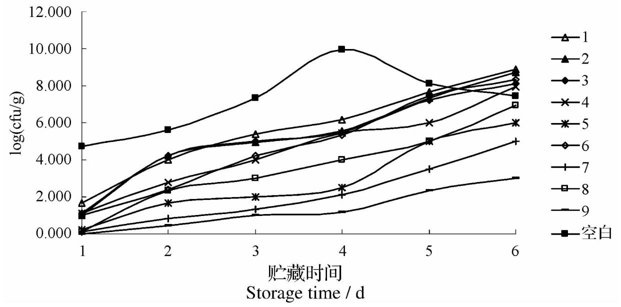

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种研究室羽鹿牧太主任研究员的指导,在此表示诚挚的感谢。

参考文献

[1] Andre E, Hou K W. The presence of a lipid oxidase in soybean, *Glyine soya* [J]. Comptes Rendus Biologies, 1932, 194: 645-647.

[2] Sessa D J, Rackis J J. Lipid-derive flavors of legume protein products[J]. Journal of the American oil Chemists Society, 1977, 54: 468-473.

[3] Moreira M A, Tavares S R, Ramos V, et al. Hexanal production and TBA number are reduced in soybean seeds lacking lipoxygenase isoenzymes 2 and 3 [J]. Journal of Agriculture and Food Chemistry, 1993, 41(1):103-106.

[4] 张瑛, 张磊, 吴敬德, 等. 植物脂氧酶同工酶快速检测技术在无腥味大豆育种上的应用研究[J]. 大豆科学, 2003, 22(1): 50-53. (Zhang Y, Zhang L, Wu J D, et al. Study on the technique of analyzing lipoxygenase isozymes for absence of beany flavor mutants in soybean breeding [J]. Soybean Science, 2003, 22(1): 50-53.)

[5] 刘渊, 张孟臣, 张彩英, 等. 大豆脂氧酶分析鉴定技术的研究进展及在育种中的应用[J]. 中国农学通报, 2007, 23(7): 101-105. (Liu Y, Zhang M C, Zhang C Y, et al. Progress of analysis and detection methods for soybean lipoxygenase and application in genetics breeding[J]. Chinese Agricultural Science Bulletin, 2007, 23(7): 101-105.)

[6] 傅翠真. 大豆脂氧酶缺失体检测方法研究[J]. 大豆科学, 2004, 23(2): 111-113. (Fu C Z. The identification technique of soybean lipoxygenase [J]. Soybean Science, 2004, 23(2): 111-113.)

[7] 羽鹿牧太, 高橋将一, 異儀田和典, 等. ダイズ新品種「いちひめ」の育成とその特性[J]. 九州沖縄農業研究センター報告, 2002, 40: 79-94. (Hajika M, Takahashi S, Igita K, et al. Breeding and characteristics of a new soybean variety (cv. Ichihime)[J]. Bulletin of the National Agricultural Research Center for Kyushu Okinawa Region, 2002, 40: 79-94.)

[8] 丁安林, 张艳, 常汝镇, 等. 大豆脂氧酶研究进展[J]. 大豆科学, 1995, 14(1): 67-72. (Ding A L, Zhang Y, Chang R Z, et al. Advances in research of soybean lipoxygenase[J]. Soybean Science, 1995, 14(1): 67-72.)

[9] Kitamura K. Biochemical characterization of lipoxygenase lacking mutants, L-1-less, L-2-less, and L-3-less soybean [J]. Agricultural and Biological Chemistry, 1984, 48: 2339-2346.

[10] Kitamura K, Kumagai T, Kikuchi A. Inheritance of lipoxygenase-2 and genetic relationship among genes for lipoxygenase-1, -2 and -3 isozymes in soybean seeds [J]. Japanese Journal of Breeding, 1985, 35: 413-420.

(上接第 483 页)

[2] 胡明燕, 徐顺明, 刘新征. 延长鲜豆浆(豆乳)保质期的研究[J]. 食品与发酵工业, 2005(11):122-125. (Hu M Y, et al. Study on the preservation of soymilk with pasteurization[J]. Food and Fermentation Industries, 2005(11): 122-125.)

[3] 谢军, 孙晓红, 潘迎捷,等. 电解水和有机酸对虾的杀菌效果及感官品质影响[J]. 食品与发酵工业, 2010, 36(5):57-62. (Xie J, Sun X H, Pan Y J, et al. The effect of electrolyzed water and organic acid on the quality of raw shrimp[J]. Food and Fermentation Industries, 2010, 36(5): 57-62.)

[4] Venkitanarayanan K S, Ezeike G O, Hung Y C, et a1. Efficacy of electrolyzed oxidizing water for inactivating *Escherichia coli* O157:H7, *Salmonella enteritidis* and *Listeria monoyctogenes* [J]. Applied and Environmental Microbiology, 1999, 65(9): 4276-4279.

[5] 中华人民共和国卫生部. GB 4789. 2-2010. 食品安全国家标准 食品微生物学检验 菌落总数测定[S]. 2010. (Ministry of Health of People's Republic China. GB 4789. 2-2010. National food safety standard. Food microbiological examination: Aerobic plate count[S]. 2010.)

[6] 赵斌, 何绍红. 微生物学实验[M]. 北京:科学出版社, 2002: 38-40, 42-43. (Zhao B, He S H. Experiment of microbiology [M]. Beijing: Science Press, 2002:38-40, 42-43.)

[7] 杨丽, 赵宇华, 张炳欣, 等. 一株毒死蜱降解细菌的分离鉴定及其在土壤修复中的应用[J]. 微生物学报, 2005, 45(6): 905-909. (Yang L, Zhao Y H, Zhang B X, et al. Isolation and characterization of a chlorpyrifos degrading bacteria and its bioremediation application in the soil[J]. Acta Microbiologica Sinica, 2005, 45(6): 905-909.)

[8] 汪立平, 张庆华, 赵勇, 等. 变质豆浆中腐败微生物的分离及其灭杀条件研究[J]. 微生物学通报,2007, 34(3):621-624. (Wang L P, Zhang Q H, Zhao Y, et al. Separation and preliminary identification of spoilage organisms in transmutative soy milk [J]. Microbiology, 2007, 34(3): 621-624.)

[9] 中华人民共和国卫生部. GB16332-2003. 植物蛋白饮料卫生标准[S]. 2003. (Ministry of Health of People's Republic China. GB16332-2003. Hygienic standard for vegetable protein beverage[S]. 2003.)

[10] 周春晖, 黄惠华. 大豆原料胰蛋白酶抑制剂失活方法探讨[J]. 食品与发酵工业, 2001, 27(6):57-61. (Zhao X H, Huang H H. A review on the advance in the methods of soybean trypsin inhibitor inactivation[J]. Food and Fermentation Industries, 2001, 27(6): 57-61.)

[11] 汤凤霞, 蔡慧农. 微生物防腐剂 Nisin 的研究与应用[J]. 食品科技, 2002(11):46-48. (Tang F X, Cai H N. Study and application of microbial preservative nisin[J]. Food Science and Technology, 2002(11): 46-48.)

[12] 初晓东, 林宇恒, 孙志增, 等. 乳链菌肽(nisin)抗性机制的研究进展[J]. 微生物学报,2010,50(9):1129-1134. (Chu X D, Lin Y H, Sun Z Z, et al. Advances in the study of nisin resistance-A review[J]. Acta Microbiologica Sinica, 2010, 50(9): 1129-1134.)

[13] 贺松, 龚芳红, 张德纯, 等. 乳酸链球菌素对乳酸菌抑菌作用的研究[J]. 食品科学, 2009, 30(23):352-355. (He S, Xi F H, Zhang D C, et al. Antimicrobial activity of nisin against lactic acid bacteria[J]. Food Science, 2009, 30(23): 352-355.)