

RESEARCH ARTICLE

Investigation of Sugar Concentration and *Lactobacillus acidophilus* Inoculation on Pickled Turmeric Rhizome Production

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Abstract

Curcuma longa which is the source of the spice turmeric having different phytochemical constituents, and pharmacological activities. An alternative way of preserving surplus turmeric rhizomes could be fermented to pickle products. Preservation of the turmeric rhizomes by fermentation can eliminate the undesired taste and improve flavor of this herb. Different technical parameters such as sugar addition (1.5%, 2.0%, 2.5%, 3.0%, 3.5%) and *Lactobacillus acidophilus* (0.1%, 0.2%, 0.3%, 0.4%, 0.5%) affecting to the pickling process were examined. Our results revealed that 3.0% sugar, 0.3% *Lactobacillus acidophilus* (10^{10} cfu/g) as starter culture were adequate for lactic fermentation. The consumption of pickled turmeric rhizomes helps enhance balanced human nutrition. Lactic acid fermentation retains all the natural plant ingredients while improving the quality, taste and aroma. The benefits of pickled turmeric have been better understood in terms of high content of valuable curcumin. It becomes an important phytochemical source for human health. Production of pickle from this herb can help increase added values and reduce post-harvest losses.

Keywords: *Turmeric rhizome*, *Lactobacillus acidophilus*, *Pickled*, *Fermentation*, *Starter culture*, *Sugar*.

Introduction

Curcuma longa L. is a member of the ginger family (Zingiberaceae) and used widely for the treatment of various ailments. Turmeric rhizome is one of most important herbs popularly used in Vietnam. Turmeric is used for its flavouring properties as a spice, food medicine as it is associated with a variety of important beneficial properties [1].

Current traditional medicine claims its powder against gastrointestinal diseases, especially for biliary and hepatic disorder, diabetic wounds, rheumatism, inflammation, sinusitis, anorexia, coryza and cough [2]. The coloring principle of turmeric is called curcumin, which has yellow color and is the essential component of this plant [3].

Curcumin extracted from turmeric rhizomes has been used in traditional medicine to prevent bacterial and fungal growth. It has been used as an ingredient in food recipes [4]. Pickling is the oldest and useful method which is used for the preservation of food by anaerobic fermentation or immersion in the vinegar and resulting food is called pickle [5].

Pickled products by lactic acid fermentation have unique flavor and great healthful effects. These products contain pigments such as flavonoids, lycopene, anthocyanin, β -carotene and glucosinolates [6]. Pickle products can play an important role in intestinal functions such as modulating immunity, lowering cholesterol and improving lactose intolerance [7].

Vegetable can be preserved by fermentation, direct acidification or a combination of these along with other processing conditions and additives to yield products that are referred as pickles [8]. Lactic acid fermentation of vegetables has an industrial significance only for cucumbers, cabbage and olives [9].

Due to pickling process texture and flavour of pickled vegetables are changed and after pickling show firm texture, translucent appearance and longer shelf-life [10]. Pickles contain phytochemicals and minerals which come from ingredients, therefore pickles are useful against different diseases such as cancer, inflammation, brain dysfunction, atherosclerosis [5].

There was not any research mentioned to the pickling of turmeric rhizomes. Purpose of our study focused on the effect of different parameters such as sugar concentration, ratio of lactic bacteria inoculation to chemical and sensory characteristics of pickled turmeric rhizomes.

Material and Method

Material

Turmeric rhizomes were obtained from Hau Giang province, Vietnam. After collecting, they must be quickly conveyed to laboratory for experiments. They were washed thoroughly under tap water to remove dirty particles before peeled and sliced in thickness of about 0.5 mm. *Lactobacillus acidophilus*, sugar, salt, phenolphthalein, NaOH were supplied from Ho Chi Minh city, Vietnam.

Researching Procedure

Sliced turmeric rhizomes were steamed for 30 seconds before experiments. They were arranged in glass jar and poured with salt solution (6%) containing different sugar concentrations (1.5%, 2.0%, 2.5%, 3.0%, 3.5%). The ratio of slice turmeric rhizomes and mixture of salt and sugar solution was 1:1. This composite was fermented for 2 weeks at room temperature (30°C) with the addition of 0.1%, 0.2%, 0.3%, 0.4%, 0.5% *Lactobacillus acidophilus* (10^{10} cfu/g). Total acidity (g/l) and sensory score were evaluated to define the optimal parameters.

Antioxidant Capacity and Statistical Analysis

Total acidity (g/l) was measured by titrating 10 ml of fermenting extract in 50 ml Erlenmeyer flask using 0.1N NaOH and 1% phenolphthalein as the indicator, the total acidity are expressed as lactic acid (AOAC,

2000). Sensory score was evaluated by a group of panelists using 9 points-Hedonic scale. The experiments were run in triplicate with three different lots of samples. Statistical analysis was performed by the Stat graphics Centurion XVI.

Result & Discussion

Effect of Sugar Concentration on Quality of Pickled Turmeric Rhizome

Salt and sugar enables a natural fermentation to occur by selecting for the lactic acid bacteria present on the cucumbers and inhibiting salt-sensitive spoilage bacteria [11]. Salt is an essential in food as it improves the preservative, technological and sensory quality of food [12]. Salt is one of the most commonly employed agents for food conservation, allowing considerable increase in storage time by reducing water activity [13].

As sugar convert to the lactic acid the condition become acidic and inhibits the growth of pathogens and other non acidic tolerant microorganism's especially aerobic spoilage microorganisms [14]. In this our experiment, different sugar concentrations (1.5%, 2.0%, 2.5%, 3.0%, 3.5%) for lactic fermentation were verified. The fermentation was performed in 2 weeks at 30°C with 0.1% *Lactobacillus acidophilus* (10^{10} cfu/g) inoculation as starter culture. Our results revealed that 3.0% sugar supplementation was appropriate for this lactic bacteria growth and metabolism (see Table 1).

So this value was selected for further experiments. In another similar report, ginger (*Zingiber officinale* Rosc.) was pickled by *Lactobacillus plantarum* in 2.5% w/w salt and 5 days fermentation at 26°C with total acidity 0.92% [15].

Table 1: Effect of sugar concentration (%) on quality of pickled turmeric rhizome

Sugar (%)	1.5	2.0	2.5	3.0	3.5
Total acidity (g/l)	0.46±0.01 ^c	0.53±0.02 ^{bc}	0.59±0.01 ^b	0.65±0.03 ^a	0.63±0.01 ^{ab}
Sensory score	4.73±0.00 ^c	5.01±0.03 ^{bc}	5.74±0.02 ^b	6.25±0.00 ^a	6.01±0.01 ^{ab}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant ($\alpha = 5\%$)

Effect of Lactic Bacteria Ratio in Starter Culture on Quality of Pickled Turmeric Rhizome

Pickled products by lactic acid fermentation have unique flavor and great healthful effects. Vegetable can be preserved by fermentation, direct acidification or a

combination of these along with other processing conditions and additives to yield products that are referred as pickles [8]. Pickling process is relatively a good method for the preservation of phenolic acids in vegetables [10].

In our research, mixture of sliced turmeric rhizomes salt+ sugar solution was fermented for 2 weeks at room temperature (30°C) with the addition of 0.1%, 0.2%, 0.3%, 0.4%, 0.5%

Lactobacillus acidophilus (10¹⁰ cfu/g). Our findings revealed that 0.3% *Lactobacillus acidophilus* (10¹⁰ cfu/g) as starter culture was adequate for lactic fermentation (see Table 2).

Table 2: Effect of lactic bacteria ratio in starter culture on quality of pickled turmeric rhizome

% <i>Lactobacillus acidophilus</i> (10 ¹⁰ cfu/g)	0.1	0.2	0.3	0.4	0.5
Total acidity (g/l)	0.65±0.03 ^c	0.74±0.00 ^{bc}	0.87±0.02 ^b	0.95±0.01 ^{ab}	1.03±0.02 ^a
Sensory score	6.25±0.00 ^c	7.06±0.01 ^{bc}	8.45±0.03 ^a	8.11±0.02 ^{ab}	7.76±0.00 ^b

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant ($\alpha = 5\%$)

Conclusion

The volatile aromatic components give a mild spicy, pungent and pleasant flavor. Turmeric is an essential spice all over the world with a distinguished human use. Apart from the use as spice, it is used as traditional medicine because of its beneficial properties. We have

successfully found out some variables affecting to the pickling production from turmeric rhizomes. The findings of this investigation help diversifying the multiuse of turmeric rhizome. Production of pickle from this vegetable can improve the added value as well as to reduce post-harvest losses from this valuable source.

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