The influence of cooked rice addition on the quality of *joruk*, a freshwater fish fermented product from Indonesia

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Abstract. *Joruk* is a fermented fish product made from freshwater fish (*Wader pari*: Cyprinidae), cooked rice, solar salt, and brown sugar originating from South Sumatra province, Indonesia. This research aimed to acquire the exact addition of cooked rice to produce *joruk* with the best microbiological, chemical, and sensorial properties. The treatment was the concentration of cooked rice that consisted of six different levels, i.e., 5, 10, 15, 20, 25, and 30% (w/w) in four replications. The results showed that the addition of 20% of cooked rice provided the best character of *joruk* product. The characteristics were pH value of 4.92, lactic acid of 6.92%, volatile base of 84.55 mgN/100 g, the moisture content of 63.30%, the ash content of 4.25%, the fat and protein content of 3.61% and 28.82% respectively, LAB of 8.61 log CFU/g, total microbes 13.74 log CFU/g and yeast 4,16 log CFU/g. The sensorial character of *joruk* was blackish-brown of color (7.3), slightly sour of smell (6.3), salty-runny taste (7.8), and a desirable non-intact appearance (6.5).

1. Introduction

Joruk is a typical fermented freshwater fish product originating from Ogan Komering Ulu Regency, South Sumatra, Indonesia which has potential functional properties. The raw materials used in making *joruk* are freshwater fish (*Rasbora* sp: Cyprinidae), solar salt, cooked rice, and palm sugar. *Joruk* is consumed by frying or roasting to perform the distinctive aroma.

The addition of cooked rice in the processing of *joruk* not only provide a distinctive aroma but also stimulate the growth of beneficial microorganism such as lactic acid bacteria (LAB). One of the most advantages of fermented fish products is the high of LAB that would degrade the starch into simpler compounds and have benefits for body health [1]. Most LABs were probiotic microbes that play a beneficial role in improving digestive health.

According to Koesoemawardani et al. [2], the concentration of each raw material in making *joruk* was varied, and there is no processing standard. Traditionally, the amount of palm sugar added to the *joruk* fermentation process ranging from 20-50%, while cooked rice ranging from 10-20%. It causes an

enormous diversities in the quality of *joruk* among the local producers. Sometimes they produced an undesirable juicy characteristic.

Koesoemawardani et al. [2] optimized the addition of palm sugar and suggested 20% of palm sugar with the highest amount of LAB. High level of sugar (above 40%) would binding the free water, consequently unable to be used by microbes and inhibit microbial growth [3]. In addition, Nuraini et al. [4] stated that the addition of 40% cooked rice could reduce the pH and TVB value of tilapia bekasam, but increase the lactic acid value, total sugar, and lysine.

There was no report concerning of cooked rice addition o the quality of *joruk*. Therefore, the purpose of this research is to determine some amount of cooked rice additions that are appropriate to produce the best characteristics of *joruk* product, including chemical, microbiological, and sensorial properties.

2. Materials and methods

2.1. Research methodology

This research was conducted using a Completely Randomized Design (CRD). The treatment is the different concentration of cooked rice (N) which added to process *joruk* product were: 5% (N1), 10% (N2), 15% (N3), 20% (N4), 25% (N5), and 30% (N6) were replicate 4 times.

The best treatment calculated based on De Garmo et al. [5] by an effectiveness index (EI) among *joruk* parameters, then followed by evaluated for the total volatile base (TVB), protein, fat, ash, and sensorial properties of *joruk* product.

2.2. Joruk processing

Materials for making *joruk* consisted of freshwater fish locally called *wader pari* (*Rasbora* sp.), cooked rice (rice variety IR 64), palm sugar obtained from the traditional producer, and solar salt. The *wader pari* then washing and draining following by adding 10% of solar salt and 20% palm sugar. The cooked rice added according to the treatment and followed by stirring. Jars then sealed tightly and fermented for seven days.

2.3. Parameters analysis

The characteristic of the product performed by microbial and chemical analysis. The microbiological analysis was carried out by total microbes on the nutrient agar medium [6], total yeast [6], and lactic acid bacteria (LAB) on the MRSA medium [7]. The chemical properties including the pH value employing a pH meter according to SNI [6], lactic acid [8], TVB [9], moisture content [6], protein and fat content [6] and ash content determined according to SNI methods [9]. The organoleptic analysis was carried out by hedonic analysis [10]. Four kinds of analysis (color, smell, taste, and appearance) were compared to a score-based test by eight semi-trained panelists for sensory evaluation.

2.4. Data analysis

The data analyzed by variance to determine whether there were differences among treatments. The similarity of data tested by the Bartlett test or by the Tuckey test and following by the Smallest Real Difference (SRD) test at the level of 5% [11].

3. Results and Discussion

3.1. Moisture content

The addition of cooked rice showed a significant effect on the value of the moisture content of the *joruk*. The moisture content of *joruk* ranged from 62.68 to 63.70% (Table 1). The SRD test showed that the moisture content in the addition of cooked rice statistically different by 25% and 30%.

The higher the addition of cooked rice will affect the lower pf moisture content because the higher the concentration of sugar. Muchtadi and Sugiyono [3], stated that sugar could be a preservative compound relating to the ability to bind free water.

The addition of cooked rice above to 25% produced less free water of *joruk* product. The moisture content of catfish *bekasam* ranges from 72.14-74.81% [12]; and *joruk* were 56.23-64.14% [2]. Meanwhile, the level of *joruk* moisture in this study ranged from 62.68 to 63.70%.

Figure 1. Freshwater fish (*wader pari*) and *joruk* product

3.2. pH value

The pH value of *joruk* was inadequate pH range from 4.92 to 5.26 (Table 1). The pH value of *joruk* was in accordance with several fermented fish products, such as cyprinid *bekasam* were in range of 3.60–5.30 [13]; catfish *bekasam* were 3.99–4.41 [12]; red tilapia *bekasam* were 4.66 [4]; and *rusip* product was 5.98 [14]. However, the pH values lower than shrimp fermented product, such *terasi* were 7-8 [15], and *kecalok* were 6.38-7.32 [16].

The addition of different cooked rice had a significant effect on the pH value during fermentation. SRD analysis showed the addition of 30% cooked rice indicated the highest pH value of the product. The addition of cooked rice affected microbial growth and acted as a carbon source for the microorganisms. Carbohydrates hydrolyzed into simpler compounds such as dextrose, mannose, and sucrose which used by lactic acid bacteria as energy sources and produce acidic and volatile compounds. This process causes an acidic condition to the end product and lowering the pH values [17].

Khalid [18] stated that the optimum pH of lactic acid bacteria growth was 5.5-5.8. The addition of 30% of cooked rice can increase in pH value as 5.26. The increase in pH during fermentation due to the addition of sugar concentration reported by Hariyadi et al. [19], and Gianti and Evanuarini [20].

Ariyanto et al. [21] stated that a high initial sugar concentration would inhibit the fermentation rate because it inhibits the growth of microorganisms. Otherwise, Kalista et al. [12] reported that higher carbohydrates affected to lower LAB activity to produce lactic acid.

Table 1. pH, lactic acid, and moisture content of *joruk* after addition of cooked rice

Cooked rice addition	Characteristics		
	Moisture (%)	pH	Lactic acid (%)
N1 (5%)	63.70± 1.29^{c}	5.23± 0.14^{b}	6.48± 1.26^{a}
N2 (10%)	63.64± 1.03^{c}	5.18± 017^{b}	6.66± 1.39^{a}
N3 (15%)	63.55± 1.02^{c}	4.96± 0.17^{a}	6.70± 1.23^{a}
N4 (20%)	63.30± 1.29^{bc}	4.92± 0.16^{a}	6.92± 1.21^{a}
N5 (25%)	62.94± 1.22^{ab}	4.94± 0.11^{a}	6.75± 1.33^{a}
N6 (30%)	62.68± 1.18^{a}	5.26± 0.32^{b}	6.21± 1.36^{a}
$SRD_{0.05}$	0.45	0.21	1.32

Exp.: different character showed a significant treatment on SRD 5%.

3.3. Lactic acid

The lactic acid values on *joruk* assumed originating from LAB activity during fermentation degrading the carbohydrate sources from cooked rice and palm sugar. The lactic acid values ranged from 6.21–6.92%, but the variance analysis showed that the different addition of cooked rice had no significant effect on the lactic acid concentration of *joruk*.

It suspected of the low activity of some LAB in osmotic stress condition due to the high sugar content [22]. It is the reason why the addition of different concentration of cooked rice did not affect the increase of lactic acid concentration. The seven days fermented *joruk* product played an optimum LAB growth and affected the relatively similar concentration of lactic acid in all treatment.

We also reported the decreasing of pH value during the fermentation period from 6 to 4.92-5.26 at the end fermentation. It caused by the presence of organic acids, especially lactic acid, from the breakdown of carbohydrates by lactic acid bacteria followed by a decrease in pH value [12][23].

3.4. Total Microbes

The total number of microbes ranged from 13.48–13.77 log CFU/ g. Variance analysis showed that the addition of cooked rice did not provided significantly affect the total microbial value. It caused the processing of *joruk* occurred under spontaneous fermentation employing wide varies of microbial types such as LAB, mold, and yeast.

Koesoemawardani et al. [2], reported that the addition of palm sugar concentration did not provide a significant effect on *joruk*. Inline to bekasam product that the different carbohydrates sources did not significantly affect microbial growth [13].

Table 2. Microbial profile of *joruk* after addition of cooked rice

Cooked rice addition	Microbial profile (log CFU/g)		
	Microbe	Yeast	LAB
N1 (5%)	13.77± 0.11^{a}	4.41± 0.03^{bc}	8.38± 0.28^{a}
N2 (10%)	13.58± 0.34^{a}	4.38± 0.05^{bc}	8.35± 0.17^{a}
N3 (15%)	13.48± 0.29^{a}	4.35± 0.17^{bc}	8.51± 0.17^{a}
N4 (20%)	13.74± 0.17^{a}	4.16± 0.11^{a}	8.61± 0.44^{a}
N5 (25%)	13.73± 0.11^{a}	4.28± 0.04^{ab}	8.53± 0.39^{a}
N6 (30%)	13.54± 0.21^{a}	4.44± 0.00^{c}	8.31± 0.31^{a}
$LSD_{0.05}$	0.39	0.13	0.34

Exp.: different character showed a significant treatment on LSD 5%.

3.5. Lactic acid bacteria (LAB)

The total number of *joruk* LAB ranged from 8.31–8.61 log CFU/ g (Table 2). Some report revealed that LAB of fermented fish product ranging from 6,48-10,15 log CFU/ ml [24][25].

Based on the results of the study, the total value of lactic acid bacteria in the *joruk* is higher than the *bekasam* product. The microbes profile on *joruk* was dominated by LAB and considered high comparing to *bekasam* microbes. It caused the addition of both cooked rice and palm sugar during the making of *joruk* than only cooked rice addition on *bekasam* processing.

Rice and palm sugar were providing more carbon sources to fulfill the energy of microbes and will make an appropriate environment for the growth of lactic acid bacteria.

The different concentrations of cooked rice addition did not provide a different growth of LAB. It indicated that LABs were in the seven days fermented *joruk* had undergone a stationary phase and has been at the optimum growth. The addition of cooked rice would also cause too much-containing *joruk*,

resulting in plasmolysis of the LABs. Maryana [26] also noted that the addition of different carbon sources had no significant effect on the LAB, including *L. plantarum* and *L. acidophilic*. It was due to the excessive proportion of carbon sources and caused a hypertonic condition and lysis cells.

3.6. Total yeast

The total yeast was 4.16–4.44 log CFU/ g, and lower than total yeast in the *rusip*, an anchovy fermented product that reported in the range of 4.57 to 5.94 CFU/ g [14]. Variance analysis showed that the addition of cooked rice had a significant effect on yeast growth (Table 2). Presumably, lactic acid bacteria have been in the stationary phase, where lactic acid bacteria will not grow and produce lactic acid, which affected pH. In this condition, the yeast will grow.

The total value of yeast is high, allegedly related to the moisture content of the *joruk*, which valued at 63.55-63.70% where in this condition, yeasts will quickly grow. Meanwhile, the total yeast value is low because the addition of rice causes the pH value to be lower so that the yeast cannot grow optimally.

The high proportion of carbon sources caused hypertonic condition and affected bacteria cells lysis [26]. The yeast grows because the LAB was lysis. Carbohydrates are the primary substrate for yeast growth, especially as a carbon source in the metabolic system [17].

Joruk fermentation occurred within spontaneous fermentation that allowed growing all kinds of due to appropriate nutrition, pH, aw, and temperature. The nutrients needed for yeast growth are carbon, nitrogen, vitamins, and minerals; these nutrients are required for energy sources and compile cell components [17].

3.7. Best treatment and the characteristic

Determination of appropriate concentration of cooked rice added to the quality of *joruk* conducted by chemical and microbiological properties. According to an effectiveness index (EI) (data not shown) suggested that N4 treatment provide the best characteristics (Table 3). The product then analyzed for total volatile base (TVB) content, proximate, and sensory properties to display a complete quality profile of *joruk* product.

Table 3. Characteristic of *joruk* added by 20% of cooked rice (N4)

Joruk characteristic	Values
TVB (mgN/100g)	84.55± 2.31
Protein (%)	28.82± 0.20
Fat (%)	3.61± 0.12
Ash (%)	26.97± 0.35
Moisture (%)	63.30± 1.29
pH	4.92± 0.16
Lactic acid (%)	6.92± 1.21
LAB (log CFU/g)	8.61± 0.44
Microbe (log CFU/g)	13.74± 0.17
Yeast/ yeast (log CFU/g)	4.16± 0.11
Organoleptic	
- Color	5.37± 1.7
- Smell	7.37± 1.8
- Taste	7.8± 0.9
- Appearance	6.5± 2.4

Furthermore, TVB value in this study was 84.55 mg N/ 100g. In accordant to Azizah and Wikandari [27], was 97.30 mg.N/ 100g, as well as TVB of milkfish *bekasam* as 91.45 mg.N/ 100g [24].

The total volatile base provides the freshness of fish, the higher the TVB, the lower the level of freshness of the fish [28]. The increasing of TVB value due to microbial activity during fermentation, which degrading protein onto simpler and volatile compounds [29].

The protein content of *joruk* was 28.82%, fat content was 3.61% and ash of 4.25%. While the product of *bekasam* made from seluang fish has a protein content of 14.68%, fat and ash contents were 7.94% and 13.13% respectively [30].

Sensorial analysis of *joruk* has a quality characteristic that is blackish brown with color intensity of 5.3, while the aroma has a slightly sour (7.3) and have a salty-runny taste (7.8). Aulia et al. [31], stated salty-sour provide a distinctive flavor of the product because of the increase of amino acid content during fermentation period due to the breakdown of proteins. Furthermore, *joruk* has the appearance of non-intact (6.5) and provided whole fish appearance at the end product.

4. Conclusion

The addition 20% of cooked rice provided the best quality of *joruk* supported by chemical, microbiological, and sensorial properties. The chemical characteristics of pH 4.92, total lactic acid 6.92%, TVB 84.55 mg/ 100g, levels 63.30% moisture, 4.25% ash content, fat and protein content 3.61% and 28.82% respectively. Microbiological criteria were total LAB of 8.61 log CFU/ g, total microbes 13.74 log CFU/ g and yeast 4.16 log CFU/ g. The sensorial properties were blackish brown (7.3), slightly sour of smell (6.3), salty-runny of taste (7.8), and desirable a non-intact appearance (6.5) at the end of the product.

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