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Amino acid and fatty acid profile of instant kanji rumbi porridge as supplementary feeding for undernutrition children

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ABSTRACT

Background: Specific undernutrition interventions focused on children aged 6-24 months include exclusive breastfeeding and providing complementary food rich in animal protein and available locally for toddlers. Instant kanji rumbi porridge is a local food from Aceh.

Methods: The development of instant kanji rumbi porridge used an experimental design. Protein (Kjeldahl), amino acids (Ultra Performance Liquid Chromatography/UPLC), and fatty acids (Gas Chromatography/GC-FID) were analyzed. Amino acid and fatty acid profile data were tabulated and analyzed descriptively.

Results: Kanji rumbi porridge had a protein content of 20.22 g/100 grams and met the established complementary food standards. It contained essential, non-essential, and conditionally essential amino acids with an Amino Acid Score of 61% and valine as the limiting amino acid. The product also has complete fatty acid content, especially omega 3, 6, and 9.

Conclusion: Instant Kanji Rumbi porridge can be a supplementary feeding for undernutrition children with protein, essential amino acids, and essential fatty acids.

KEYWORDS

Child nutrition, micronutrients, complementary food, preventive nutrition, pediatric health.

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INTRODUCTION

The toodlers period is part of the critical period for child growth and development. It is characterized by identifiable phases such as exclusive breastfeeding (0-6 months of age) and complementary feeding (6-24 months), both of which are determinants of child growth and development[1]. Good nutrition and healthy growth during the 1000 HPK period will provide permanent benefits throughout the child's life, so this period is referred to as the best period for nutrition improvement interventions because it is more likely to prevent irreversible impacts[2].

Undernutrition in children before the age of two can cause short-term impairments in physical health such as growth and long-term impairments in psychosocial health such as cognitive, mental and motor development[3]. Undernutrition at this age will have a permanent impact on growth, leading to stunting, and development, characterized by reduced capacity for brain development.

Undernutrition children have high nutrient requirements, while the quantity and quality of food consumed is very limited (less diverse and not nutrient dense), making them vulnerable to weight loss and undernutrition[4]. Undernutrition children have inadequate levels of Essential Amino Acids and suffer from various other metabolic disorders[5]. This is partly due to the poor protein quality of complementary foods, especially low animal foods. Animal-sourced complementary foods are rich in essential amino acids, in addition to being a source of other essential macronutrients (such as energy, high-quality protein, and fatty acids), they are also rich in micronutrients (such as zinc, iron, iodine, magnesium, potassium, vitamin B, vitamin A, and vitamin D) that are building blocks and regulate processes involved in child growth and development[1].

Government policy on eleven specific undernutrition intervention programs focuses on children aged 6-24 months, one of which is through exclusive breastfeeding and complementary feeding rich in animal protein for toddlers. According to the guidelines for local food-based supplementary feeding for undernutrition children, increasing nutrient intake from diverse foods and adding animal protein sources of at least two types[6]. The WHO has also previously classified the problem of undernutrition as underweight with the BB/U indicator (Z-3.0 SD to <-2.0 SD), so it is necessary to provide nutrient-dense and locally available supplementary foods to increase weight, height and recovery functions and prevent undernutrition[7].

Instant kanji rumbi porridge is a local food from Aceh that has been formulated according to the needs of toddlers and served in instant form. Bubur kanji rumbi is processed from various types of food sources of nutrients, rice as the main ingredient of bubur kanji rumbi, while the additional ingredients come from potatoes, carrots, chicken/beef/shrimp/eggs/fish, tomatoes, coconut milk, and other typical herbs and spices[8,9]. Rice and potatoes contain carbohydrates and protein, carrots and tomatoes contain vitamins and minerals, while coconut milk and oil are sources of fat[10].

The most important additive in the processing of instant flour porridge is using two types of animal protein sources, namely chicken meat and quail egg flour. Animal protein from chicken meat and eggs is a good source of protein and micronutrients for the growth and development of toddlers and children, so it is important to add in complementary food[10–12]. Quail eggs are high in nutrients such as amino acids, fatty acids, vitamin E, and the minerals nitrogen, iron and zinc[13].Quail egg meal is one type of processed quail egg that has a high content of protein, minerals, and essential amino acids[14]. Essential amino acids are required for protein synthesis which is necessary for child growth and development[15]. Based on the ingredients used to make it, kanji rumbi porridge has the potential to be used as an alternative complementary food that is nutrient-dense, especially protein and is thought to also contain a number of amino acid and fatty acid profiles that can support the growth and development of undernutrition children. Therefore, this study aimed to analyze the amino acid and fatty acid content of instant kanji rumbi porridge.

METHODS

Design, Place and Time

The development of instant kanji rumbi porridge used an experimental design. This research was conducted in October-December 2023. The processing of instant kanji rumbi porridge was carried out at the Seafast Laboratory of IPB. Analysis of the amino acid profile and fatty acid content of instant rumbi porridge was conducted at Saraswanti Indo Genetech (SIG) Laboratory, Bogor.

Ingredients and Equipment

The ingredients used in the preparation of instant kanji rumbi porridge are white/ground rice, purebred chicken meat, quail egg flour, carrots, potatoes, tomatoes, coconut milk, palm oil; spices or herbs (shallots, garlic, cumin, fennel, pepper, coriander, cardamom, star anise, cinnamon, curry leaves, pandanus leaves, serei, salt, water) which are mostly available in traditional markets. The quail egg flour used was 5 grams obtained from CV Slamet Quail Farm, Sukabumi, West Java. The equipment used in the research of instant bubur kanji rumbi product development consisted of fresh bubur kanji rumbi cooking equipment (digital scales, steam jacket kettle, double drum dryer, knives, blender, stirrer, cutting board, stainless container, mixer).

The Development of Instant Kanji Rumbi Porridge

Modification of the standard instant kanji rumbi porridge recipe from three sources, namely the book "Guidelines for the Development of Local Food-Based Recipes for Healthy Breakfast Menus for School Children", the book "Local Food-Based Complementary Food Processing as an Effort to Prevent Stunting and Anemia in toddlers in Aceh" and traditional recipes commonly used by the people of Aceh to produce the right formula to meet the snack food standards for children aged 12-23 months, especially the content of energy, protein and amino acids applied in Microsoft excel 2010[8–10].

The process of making instant kanji rumbi porridge begins with making kanji rumbi porridge in fresh form, then making it in instant form. The process of making instant kanji rumbi porridge is shown in Figure 1. It can be seen that the process of making instant fresh kanji rumbi porridge includes several stages; (1) boiling rice until the water shrinks (almost forming porridge) using a steam jacket (2) sautéing chicken meat together with fine spices and coarse herbs until it produces tender meat texture using Teflon frying pan (3) steaming potatoes and carrots until tender texture using a steamer (4) re-boiling all ingredients to form porridge (5) drying fresh kanji porridge using a Drum Dryer to form a smooth slab of instant kanji rumbi porridge (T outlet: 90^{o}C, T inlet: 130^{o}C, speed: 10 rpm), (6) mixing instant kanji rumbi porridge with quail egg flour.

Analysis of Chemical Characteristics of Instant Kanji Rumbi Porridge

Analysis of the chemical characteristics of instant Kanji rumbi porridge consisted of analysis of protein content, amino acids, and fatty acids. Protein content was analyzed using the Kjeldahl method[16]. Amino acid profile analysis uses the Ultra Performance Liquid Chromatography (UPLC) method, while fatty acid profile uses the Gas Chromatography (GC-FID) method[17].

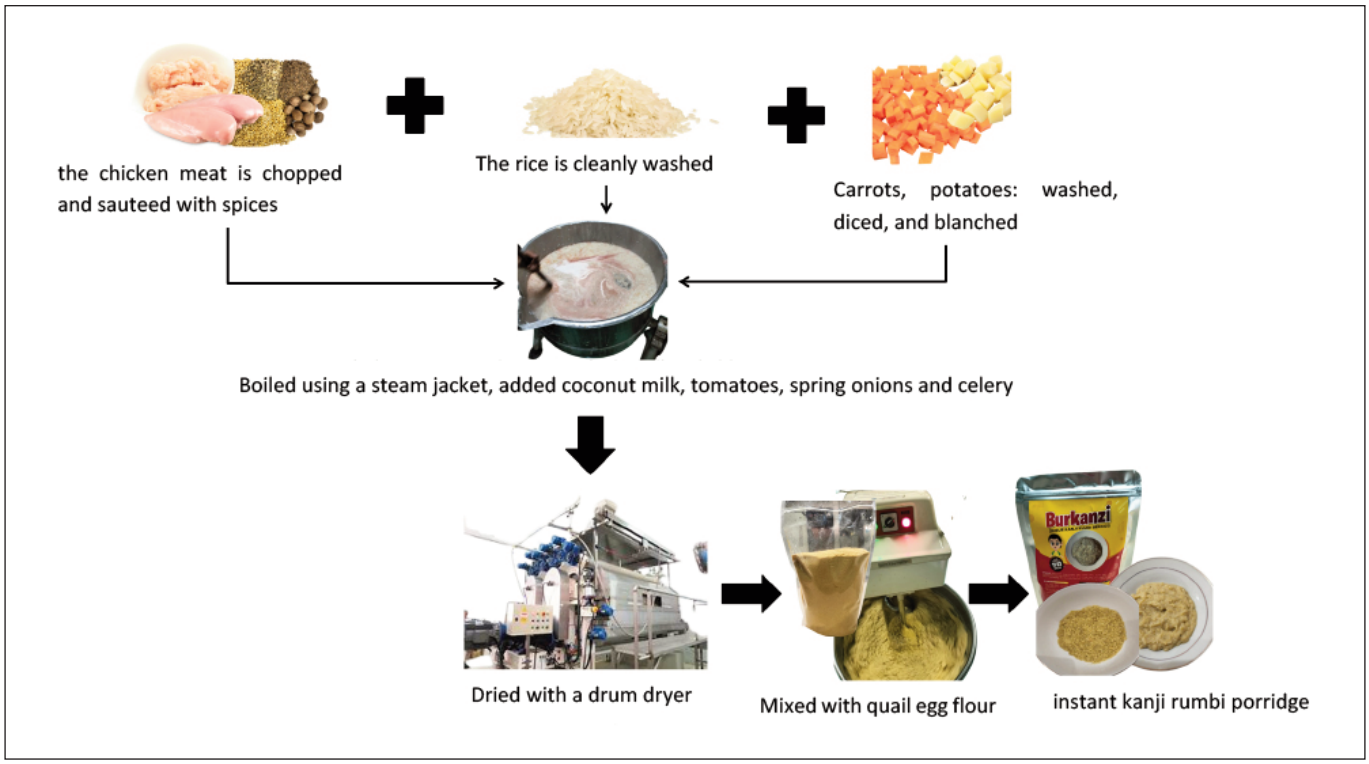

Figure 1. Procedure for making instant kanji rumbi porridge

Data Analysis

The values of each parameter were analyzed using the Microsoft Excell 2016 computer program and the Social Science Statistics Program (SPSS) version 16.0 for Windows. Data were presented as mean ± standard deviation (SD). Amino acid and fatty acid profile data were tabulated and analyzed descriptively and presented in tables.

RESULTS AND DISCUSSION

Amino Acid Profile of Instant Kanji Rumbi Porridge Complementary Food

Complementary feeding is nutritious food and drink given to toddlers aged 6-24 months in addition to breastfeeding according to medical indications, to achieve nutritional adequacy[18]. The Indonesian government has set the standard rules for complementary food snacks in Food and Drug Administration Regulation No. 24/2019 and SNI for complementary food through SNI 01-7111.1-2005. Table 1 shows a comparison of the protein analysis results of instant kanji rumbi porridge with these standards. It can be seen in Table 1 that kanji rumbi porridge has met the established complementary food standards.

The results of amino acid analysis of instant kanji rumbi porridge are shown in Table 2. Instant kanji rumbi porridge contains essential and non-essential amino acids. The dominant types of essential amino acids found in instant kanji rumbi porridge products are leucine, lysine, phenylalanine, threonine, valine, histidine, isoleucine, while tryptophan is the lowest type of amino acid. The most abundant non-essential amino acid profiles in instant kanji rumbi porridge

Table 1. Protein Content Comparison of Instant Kanji Rumbi Porridge with Standard MP-ASI

Standardized complementary snack* (g/100 kkal)			**SNI MP-ASI** (g/100 g)**		
analysis result	Standard	Interpretation	analysis result	Standard	Interpretation
0.8	0.8-5.5	Fulfill	20.22	8- 22	Fulfill

* Food and Drug Administration Regulation No. 24/2019.
** SNI 01-7111.1-2005.

Table 2. Amino Acid Profile of Instant Kanji Rumbi Porridge per 100 g Sample

Amino Acid Profile Content	mg/100 g
Asam amino essensial	
Histidine	373.39 ± 0.20
L-Lysine	804,64 ± 2.67
L-Leucine	1033.36 ± 2.22
L-Isoleucine	347.36 ± 0.00
L-Threonine	600.16 ± 2.41
L-Valine	524.22 ± 0.78
L-Phenilalanine	685.54 ± 2.09
L-Methionine	303.61 ± 0.14
L-Tryptophane	194.01 ± 0.15
Non essensial	
Aspartic acid	1257.58 ± 2.96
L-Serine	894.20 ± 1.92
L-sistin	1001.72 ± 0.00
L-Prolin	808.22 ± 2.41
L-Alanine	850.10 ± 2.39
L-tirosin	589.64 ± 1.25
Conditional essensial	
L-Arginine	1251.71 ± 3.02
Glutamic acid	2138.52 ± 7.00
L-glisin	1214.38 ±2.98

were glutamine, aspartic acid, arginine and glysine. The contribution of essential and non-essential amino acids in this instant kanji rumbi porridge comes from the combination of food ingredients used in the processing process, especially supplemented with animal protein sources from chicken meat and quail egg flour.

Table 3 shows that the amino acid scores (AAS) that are in accordance with the recommendations of FAO and WHO that have met 100% are methionine + cystine, phenylalanine + tyrosine, threonine, and tryptophan. AAS with a score of 70-87 are isoleucine, leucine, and lysine, while the AAS score of >60 is valine.

Table 3. Amino Acid Score (AAS) of Instant Kanji Rumbi Porridge

Essential amino acids	Grade in sample	FAO/WHO Standard[19]	AAS (%)
	(mg/g protein)		
Isoleucine	17.37	20	87
Leucine	51.67	66	79
Lysine	40.23	57	71
Methionine + Sistine	65.26	27	100
Phenilalanine + Tyrosine	63.76	52	100
Treonin	31.01	31	100
Triptofan	9.70	8.5	100
Valine	26.21	43	61

Fatty Acid Content of Instant Kanji Rumbi Porridge

Table 4 shows the results of fatty acid profile analysis in instant kanji rumbi porridge consisting of 15 types of fatty acids classified into saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids. The highest saturated fatty acid is Palmitic Acid (C16:0) which is 3688.05 mg/100 grams. Oleic is the dominant monounsaturated fatty acid. Oleic is also known as omega 9.

DISCUSSION

The quality and quantity of protein will determine the adequacy of intake in meeting the required amino acids. Amino acid composition describes the quality of protein in food[15]. Essential amino acids are used as a reference to assess the quality of a protein because these amino acids cannot be synthesized by the body. A steady intake of amino acids is essential to ensure all the body's proteins can be assembled and perform their vital functions for optimal growth, development and health[20].

Instant kanji rumbi porridge is a complementary food product (MP-ASI) snack formulated according to the nutritional needs and acceptability of toddlers aged 12-23 months[21]. In this study, in addition to protein analysis, amino acid analysis was also carried out, both essential and non-essential. Non-essential amino acids are types of amino acids that can be produced by the body and essential amino acids are amino acids that cannot be produced by the human body, so they must be obtained from food[22,23]. There are nine types of essential amino acids detected in instant kanji rumbi porridge including; histidine, lysine, leucine, isoleucine, threonine, va-

Table 4. Fatty acid profile of instant kanji rumbi porridge per 100 g sample

Contents	mg
Saturated fatty acid (SFA):	
Caproic Acid (C6:0)	39.65±0.21
Caprylic Acid (C8:0)	366.00±0.98
Capric Acid (C10:))	305.15±2.19
Lauric Acid (C12:0)	2692.45±5.30
Myristic Acid (C14:0)	1268.10±3.68
Palmitic Acid (C16:0)	3688.05±7.00
Heptadecanoic Acid (C17:0)	13.75±0.21
Stearic Acid (C18:0)	1012.00±1.13
Arachidic Acid (C20:0)	21.10±0.00
Total Saturated Fat	**9430.10±3.67**
Monounsaturated Fatty Acids (MUFA):	
Palmitoleic Acid (C16:1)	318.85±3.46
Oleic Acid (C18:1) (omega 9)	4941.40±0,14
Eicosenoic Acid (C20:1)	18.80±0.14
Heptadecanoic Acid (C17:1)	8.55±0.07
Mirisoleic Acid (C14:1)	11.55±0.21
Total Monounsaturated Fats	**5328.70**±3.67
Polyunsaturated Fatty Acids (PUFA):	
Linoleic Acid (C18:2) (omega 6)	1801.50±1.27
Alpha-linolenic Acid (C18:3) (omega 3)	50.30±0.35
Arachidonic Acid (C20:4)	182.65±0.63
Total Polyunsaturated Fat	**1851.15±0.07**
Total Unsaturated fat	**7179.90±3.67**

line, phenylalanine, methionine and tryptophan[19]. The non-essential amino acids detected in the product were aspartame, glutamic acid, arginine, serine, glycine, sisitin, proline, alanine, tyrosine.

The amino acids in this porridge were influenced by the addition of quail egg flour. Quail egg meal is one of the processed quail eggs that has a protein content of 94.17 g with a high content of essential amino acids (such as leucine, phenylalanine, lysine, valine, isoleucine, threonine, methionine) and high non-essential amino acids (such as aspartic acid, alanine, glutamic acid, proline, glycine[14]. Another study, quail egg flour has a higher amino acid content of glutamic acid than other amino acids, followed by aspartic acid and leucine[24]. Glutamic acid and aspartic acid contribute to the umami flavor of the product[25].

Instant kanji rumbi porridge is high in the conditional amino acids arginine, glycine and glutamine. Some non-essential amino acids are classified as conditional amino acids which means they are only considered essential at a certain age of growth or condition, e.g. undernutrition[22]. There are three types of conditional amino acids associated with growth and stunting in toddlers, namely arginine, glycine and glutamine[5]. Glutamic acid is a type of conditional amino acid that is needed especially in undernutrition children[22]. undernutrition children require large amounts of protein, so for protein synthesis, glutamine can be added in complementary foods. Arginine is a non-essential amino acid for adults, but essential for children because it is needed for growth, so it is called a conditional amino acid[22]. Conditional amino acids are useful for increasing growth hormone production. Therefore, all complementary foods produced should contain these amino acids.

The age of toddlers is a period of rapid growth and development[26]. During this period, children need adequate quality and quantity of nutrient intake, especially protein. Protein intake is important because it provides essential amino acids needed for protein synthesis, which is necessary for growth[27]. Essential amino acids are very important for the human body because they are precursors in various metabolic processes of the body[22]. Leucine is an essential amino acid that is indispensable for the growth of children and maintaining nitrogen balance. Leucine is also useful for the breakdown and formation of muscle proteins. Lysine is needed for tissue growth and repair, so it is very important and needed in the growth and development of children.

Various studies support the relationship between growth and amino acid levels in undernourished children. A study from South Mawawi Rural in children aged 12-59 months who were stunted had 15-20% lower blood levels of amino acids and other protein markers than normal toddlers[5]. Types of amino acids that are positively correlated with growth and stunting in toddlers include; tryptophan, isoleucine, leucine, valine, methionine, threonine, histidine, lysine, arginine, glycine, glutamine, tyrosine, asparagine, glutamate, serine and serotonin[5]. Among all these amino acids, arginine is the lowest type of amino acid found in stunted children compared to normal children[5]. A study from rural Ethiopia in children aged 6-35 months further supports the association between stunted growth and low concentrations of the mino acids tryptophan and lysine[28]. Not only can low concentrations of essential amino acids

potentially have adverse consequences for growth, they are also likely to impede children's neurocognitive development[1]. The association of low amino acid concentrations with growth and neurocognitive development is explained as suppressing protein and lipid synthesis through mTORC1 (mammalian rapamycin complex 1) and GCN2 (general control nonderepressible) and inhibiting growth[5].

The amino acid score (SAA) of instant kanji rumbi porridge is presented in Table 3. SAA is obtained by dividing the amount of amino acids (mg/g protein) by the reference pattern amino acids for children aged 6-36 months, then multiplying by 100%[20]. If the value is 100 or > 100, the amino acid score is written as 100, and if it is <100 and has the lowest value, it indicates that it is the limiting amino acid score. Table 3 shows that the chemical score of the instant kanji rumbi porridge protein sample is 61% with the main limiting amino acid being valine. The kanji rumbi porridge from this study has a score greater than beef with a score of 56%[29]. This can be caused by the use of quail egg flour as an ingredient used. Eggs are the food with the highest amino acid score with a score of 100%[30]. During growth and development, toddlers experience an increase in body mass, height, maturity of body functions, and cognitive development where this occurs due to the role of protein. Protein will be called quality if it contains a complete amino acid profile and according to individual needs. In addition, protein is declared to have good quality if it has high digestibility and high PDCAAS value, which has a value ≥ 90[30]. In this study, the PDCAAS value was not observed, so the PDCAAS score of kanji rumbi porridge cannot be known.

Fatty acids are part of fat molecules that function as substances that make up body fat or can also be used as energy producers. Fatty acids can be divided into saturated fatty acids or Saturated Fatty Acid (SFA) and unsaturated fatty acids or Unsaturated Fatty Acid which is then grouped into Monounsaturated Fatty Acid (MUFA) and Polyunsaturated Fatty Acid (PUFA). Fatty acids are the main content of foods that can influence brain development, endurance, and sensory development in toddlers. Fatty acids that have these functions include omega-3, omega-6, and omega-9 fatty acids.

The human body can make omega-9 fatty acids, so they are called non-essential fatty acids. However, the human body cannot make its own omega-3 and omega-6 fatty acids (essential fatty acids) so they must be obtained from sources outside the body. There are two types of fat from the Polyunsaturated Fatty Acid (PUFA) group that must be provided in the intake of toddlers and toddlers for brain growth and development, namely LA (linoleic acid) (C18:2 n-6) and ALA (α- Linolenic Acid) (C18:3 n-3). Essential fat intake is particularly important in the first two years of childhood to support brain growth and development.

CONCLUSION

Kanji rumbi porridge contains essential, non-essential, and conditionally essential amino acids with SAA of 61% and valine as the limiting amino acid. This product also contains complete fatty acids, especially omega 3, 6, and 9 which are needed to improve the nutritional status of undernutrition children and achieve optimal growth and development. SAA determination is one of the methods to evaluate the quality of food protein. In future research, the Digestible Indispensable Amino Acid Score (DIAAS) method can be applied to evaluate the quality of protein in kanji rumbi porridge.

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