HYDROGEN
JURNAL KEPENDIDIKAN KIMIA
https://e-journal.undikma.ac.id/index.php/hydrogen/index

October 2024. 12(5)
e-ISSN: 2656-3061
p-ISSN: 2338-6487
pp. 1108-1121

# Ethnochemistry: Studying The Food Chemistry In The Making of *Kapurung*

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**Article History**
Received: 25-09-2024
Revised: 27-10-2024
Published: 31-10-2024

**Keywords**:
ethnochemistry, food chemistry, *kapurung*,

**Abstract**
*Kapurung* is a traditional food from South Sulawesi, especially from Tanah Luwu/Luwu Raya. This food is made from sago (Metroxylon sago) as the basic ingredient which is processed together with various vegetables and meat or fish. The concept of ethnochemistry is used to examine the process of making *kapurung* through analyzing the natural ingredients used and the chemical changes that occur during processing. The way *kapurung* is made reflects the local knowledge of the community in managing existing natural resources. The research was conducted to reveal the chemical aspects and fundamental chemical activities contained in the process of making *kapurung*. This research uses descriptive qualitative research with ethnographic methods, namely observation, interviews, and documentation. Data analysis in this study used source triangulation which was carried out inductively, so that in this study key informants, main informants and supporting informants were determined on each aspect that became the object of research. The results showed that the fundamental chemical activities contained in the *kapurung* making process are the gelatinization of starch in sago, protein denaturation, fiber degradation and the dissolution of nutrients in vegetables, the Maillard reaction in fried/roasted fish/chicken, and the use of food additives in the *kapurung* making process.

**How to Cite:** Imranah, I., Yusaerah, N., Wana, N., & Faradita, U. (2024). Ethnochemistry: Studying The Food Chemistry In The Making of Kapurung. Hydrogen: Jurnal Kependidikan Kimia, 12(5), 1108-1121. doi:https://doi.org/10.33394/hjkk.v12i5.13325

https://doi.org/10.33394/hjkk.v12i5.13325



## INTRODUCTION

Traditional foods serve not only to meet nutritional needs, but also as a cultural manifestation that integrates local wisdom values and people's empirical knowledge of natural materials in their surroundings (Rajab & Munisya, 2020). *Kapurung*, a traditional food from South Sulawesi, is a good example to illustrate the interaction between chemical knowledge and cultural practices. Made from sago (Metroxylon sago), *kapurung* is a staple food for the people of Tanah Luwu in South Sulawesi and has deep cultural significance, often being served at various traditional ceremonies and family events (Firdamayanti et al., 2024).

As a main source of carbohydrates, sago provides a nutritious and economically valuable food alternative for the people of Greater Luwu. In addition to carbohydrates, *kapurung* also contributes protein from the fish or meat used, as well as various minerals and vitamins from the vegetables added to the dish (Suismono & Hidayah, 2011). *Kapurung*, with its high content of complex carbohydrates and fiber, not only provides stable energy, but also supports digestive health and helps with weight control (Barber et al., 2020). In addition, the use of vegetables in *kapurung* contributes to improved immune system and heart health, and supports healthy growth in children. Based on research, North Luwu Regency has the highest sago production in South Sulawesi, indicating the important role of sago in supporting local food security

(Mandang, 2021). By maximizing the potential of sago and *kapurung*, communities can improve their overall health and well-being.

In the context of *kapurung* production, local knowledge related to the use of sago, processing techniques, and the use of complementary ingredients such as acids and vegetables can be analysed through the principles of food chemistry. The study of food chemistry involves the study of the chemical composition of foods, including carbohydrates, lipids, proteins, water, vitamins, minerals, enzymes, food additives, flavors, and colors (Tanaka et al., 2020). On the other side, Ethnochemistry, a branch of chemistry that examines the interaction between chemistry and traditional practices, focuses on how people sustainably use natural materials for their daily needs, such as medicine, cooking, and traditional ceremonies (Aldiansyah et al., 2023) (Wahyudiati & Fitriani, 2021). Ethnochemistry analyzes how chemical processes, such as starch gelatinization in sago and protein denaturation in fish, are part of a food-making tradition passed down through generations. These processes not only preserve texture and flavor, but also increase the nutritional value of *kapurung* by using natural ingredients (Firdamayanti et al., 2024).

The way in which *kapurung* is made and consumed reflects the local knowledge of the community in managing the available natural resources. This can be seen in the way the community pours hot water over the sago until the gelatinization process occurs. This process accelerates enzymatic reactions that break down starch bonds into simpler, more soluble forms (Uhi, 2006). In addition, the local culture of consuming *kapurung* in a hot state (Suni, 2011) can also be viewed from a scientific perspective, namely the thermal process affects the starch gelatinization process, which also determines the organoleptic properties, which include the quality of texture, color and taste of *kapurung* (Sobari, 2019). Therefore, sago that has been processed into *kapurung* will experience changes in taste and texture as it cools, becoming hard and less enjoyable to eat (Kusdarianto & Sari, 2021). This approach shows how the biochemical process in *kapurung* processing involves significant amylose reactions that produce the distinctive texture and flavor. The use of local spices, such as patikala or kecombrang, also contributes to the flavor and contains chemical compounds, such as flavonoids, that have potential as natural antioxidants (Sari et al., 2022).

More than just a dish, *kapurung* reflects the traditional knowledge of the community in managing natural resources, from the processing of sago to the use of local herbs and spices. By combining ethnochemistry with the study of *kapurung*, we can see how chemistry interacts with local traditions. Chemical analysis of *kapurung* can identify nutritional components and bioactive compounds in the ingredients used, such as proteins, vitamins, and minerals. This information is not only useful for understanding nutritional value, but also deepens knowledge of how local ingredients contribute to public health. By understanding the chemical reactions in the process of making *kapurung*, we can appreciate how the Luwu people integrate their local knowledge and traditional skills. For example, the use of various spices is not only to add flavor, but also for health benefits, such as anti-inflammatory or antioxidant properties.

In addition, chemical analysis of *kapurung* helps to bridge scientific knowledge with local culture. Luwu society not only relies on modern scientific knowledge, but also maintains traditional values in resource management and food production. This approach fosters an appreciation for centuries of sustainable practices and demonstrates how empirical knowledge can contribute to formal science. In this way, it has the potential to improve food sustainability and security, as well as respect cultural diversity by preserving local food heritage.

Considering the importance of *kapurung* in the culture of the Luwu people, this study aims to examine in detail the chemical processes involved in the production of *kapurung*. The analysis will discuss the main chemical changes involved, as well as the role of each ingredient in providing nutritional value and distinctive flavor to *kapurung*. It is expected that this study will contribute to documenting the local wisdom of the Luwu people and linking modern chemical concepts to traditional practices that have been carried out for generations.

## METHOD

This study used an ethnographic approach with qualitative/naturalistic methods to explore the process of making *Kapurung* in Meli Village, Baebunta District, North Luwu Regency. The research consisted of three main stages, namely description, analysis and interpretation. In the description stage, the background of the problem was identified through observation. Then, in the analysis stage, the data was reviewed to produce accurate information according to the problem formulation. Finally, in the interpretation stage, conclusions are drawn from the analysis conducted. Data were collected through open-ended interviews, direct observation, and documentation, using interactive data analysis techniques and source triangulation to explore *kapurung* making activities and ethnochemical concepts.

The research procedure included determining the scope, selecting key informants, interviewing, and collecting data. The informants selected in this study were the spokesperson of the Luwu kingdom, sago farmers, sago processors, *kapurung* makers, and the owner of Lesehan Lela as a food stall that has been providing *kapurung* for a dozen years. The data obtained consisted of primary data through interviews and observations and secondary data in the form of documentation. Data analysis included data reduction to select important information, presentation of data in a clear and understandable format, and verification to ensure the validity and appropriateness of the data. These activities were carried out continuously throughout the research process, with the ultimate goal of communicating the community's local knowledge of *kapurung* production and its relationship to scientific knowledge.

## RESULTS AND DISCUSSION

*Kapurung* is a traditional processed sago food from South Sulawesi, particularly from Tanah Luwu / Greater Luwu (Kemendikbud, 2018). This traditional food is quite famous both locally and regionally because it is legendary (Firdamayanti et al., 2024). Among the people of the Luwu community, *kapurung* is known as pugalu. It is made from sago flour and mixed with fish or chicken and various vegetables (Suismono & Hidayah, 2011). *Kapurung* is a source of nutrients such as carbohydrates, protein, vitamins and minerals. This food is usually served with spices such as crushed peanuts, salt and flavourings, which are adjusted to taste (Rajab & Munisya, 2020).

Consuming *kapurung* has a number of significant health benefits for people, mainly due to its rich nutritional content. *Kapurung*, made from sago, is a source of complex carbohydrates that help maintain the body's energy, and its high fiber content supports digestive health. Fiber intake contributes to overall metabolic health through key pathways that include insulin sensitivity. In addition, there are clear associations between fiber intake and several pathologies, including cardiovascular health, colon health, bowel motility and CRC risk, and appetite regulation (Barber et al., 2020). Furthermore, *kapurung* is often combined with fish or meat, which provide essential protein for growth and tissue repair, and vitamins and minerals from vegetables, which strengthen the immune system and improve overall health (Samar M, 2023). Due to its balanced nutritional profile, regular consumption of *kapurung* also helps to control weight and prevent chronic diseases such as diabetes and heart disease.

To make *kapurung*, sago flour is dissolved and then poured over hot water until it resembles glue. The dough is then shaped into small rounds and dipped in yellow fish sauce to be mixed with vegetables (Kemendikbud, 2018). The sago that has been soaked in hot water will become clear *kapurung* dough if it is successful (Baharuddin, 2023). If the sago is still white, it means that the sago is not yet cooked. In the process of making *kapurung*, food additives such as salt, acid and flavour are also used to add flavour. Although it is a traditional food of the people of Tanah Luwu, there are differences in how *kapurung* is served in the North Luwu and East Palopo-Luwu areas. Around East Luwu and Palopo, *kapurung* is served by mixing all the ingredients in a large container. This includes sago balls, vegetables, shredded fish and the richly spiced *kapurung* sauce. This tradition reflects the spirit of togetherness in the local community, where all the ingredients are combined into a harmonious whole. In contrast, people in North Luwu tend to serve *kapurung* separately. In this tradition, each condiment such as sago balls, vegetables and fish/other protein sources are placed in separate containers. This separate presentation allows each person eating *kapurung* to customise their own dish to their own taste.

Figure 1. Serving *Kapurung*

The process of making *kapurung* goes through several stages that include food chemistry concepts that can be seen in Table 1.

Table 1. Food Chemistry concept in the process of making *kapurung*

| No. | Activity | Description | Chemical Concept |
|---|---|---|---|
| 1. | Preparing the *kapurung* broth  | Making *kapurung* broth is the process of cooking fresh fish, such as tuna or mackerel, to extract the juices and flavours from the fish into the cooking water. | **Protein Denaturation:** During this process, the three-dimensional structure of proteins in the fish meat, such as actin, myosin and collagen, changes due to heat exposure. At temperatures between 55°C and 75°C, proteins lose their folded structure and change into simpler forms. This process ends the biological function of the protein, but contributes to the release of flavour and nutrients, resulting in a broth that is rich in the aroma and flavour of the fish (Basuki et al., 2020). |
| 2. | Processing sago | Slowly add hot or boiling water to the reconstituted sago while stirring it constantly. This process is very important as the hot water causes the sago to | **Starch Gelatinisation:** In this process, the amylose molecules provide strength to the gel structure, while the amylopectin provides elasticity that allows the |

| No. | Activity | Description | Chemical Concept |
|---|---|---|---|
| |  | thicken and turn into a chewy dough. Stirring must be done slowly so that the sago dough has a smooth texture and does not lump. In this case, the *kapurung* dough is stirred with a special technique using a *pasangle* called *ma'buntang* until a dough called *ma'bannang* is obtained. | dough to be moulded into small rounds (Charles et al., 2005). |
| 3. | Cooking vegetables  | When vegetables are heated in boiling water, some water-soluble nutrients, such as vitamin C and vitamin B complex, as well as minerals such as potassium and magnesium, are released from the vegetable tissues and into the cooking water. The process breaks down the cell walls of the vegetables and releases the dissolved nutrients. Hence, the gravy formed from this process is rich in the essential nutrients derived from the vegetables. | **Fiber Degradation:** Cooking caused the most significant degradation of aqueous dietary fiber. In addition, the degree of polymerization (DP) and viscosity of the fiber decreased with increasing heat treatment (Margareta & Nyman, 2003). **Nutrient Solubilisation:** Cooking generally causes the greatest loss of nutrients, especially vitamin C and iron, as they dissolve in the cooking water (Sharma & Sharma, 2022). |
| 4. | Frying/grilling fish  | This process produces an attractive brownish color and delicious aroma, and creates a crispy skin texture while preserving the tenderness of the meat inside. The end result is a perfectly cooked fish that is rich in flavor and appealing to the palate. | **Maillard Reaction:** The Maillard reaction in fried or grilled fish or chicken is a chemical reaction that occurs between amino acids (from proteins) and reducing sugars when food is heated at high temperatures. This process results in a distinctive brown color as well as complex and delicious aromas and flavors. This reaction usually starts when the temperature reaches about 90ºC -130ºC (Kchaou et al., 2019). |
| 5. | Using food additives  | The use of food additives in the cooking process serves to enhance the flavour and aroma of food, giving dish its unique characteristics. Food additives used in *kapurung* are salt and MSG as flavor enhancers, Patikala as a acidulant and herbs, chili as spices, and sago as a natural emulsifier. | **Using food additives:** **Acidulant:** Acidulants such as citric, acetic, and lactic acids are commonly used to enhance flavors, impart sourness, and act as preservatives in various food product (Dziezak, 2015) (Berry, 2001) **Flavor Enhancer:** Flavor enhancers play a crucial role in improving the taste and acceptability of food products. The ability of flavor enhancers to intensify salty taste varies with the type of enhancer and the food matrix. Monoammonium glutamate |

| No. | Activity | Description | Chemical Concept |
|---|---|---|---|
| |  <br> <br> | | (MAG) and MSG are more effective than disodium guanylate (GMP) and disodium inosinate (IMP) in enhancing salty taste in certain food products (Reis Rocha et al., 2021).<br>**Herbs and Spices:** Herbs and spices are increasingly recognized for their natural preservative qualities. Their phenolic compounds play a significant role in antimicrobial effects, although high concentrations may be needed to inhibit microbial growth effectively (Martínez-Graciá et al., 2015).<br>**Emulsifier:** There is a growing demand for natural emulsifiers such as proteins, polysaccharides, phospholipids, and saponins due to consumer preference for 'clean label' products. These natural emulsifiers are effective in forming and stabilizing emulsions, although their performance can be influenced by environmental factors like pH, ionic strength, and temperature (McClements et al., 2017). |

*Kapurung* has rich historical, social, and cultural values. Although it looks simple, *kapurung* has a fairly complete nutritional content consisting of carbohydrates, protein, and fat (Adriani, 2015). The nutritional content of *kapurung* per 100 grams of edible weight (BDD) includes 14 kcal of energy, 2 grams of protein, 0.3 grams of fat, 7.8 grams of carbohydrates, and contains vitamin B2, vitamin B3, and Vitamin C (Nilai Gizi, 2018).

Based on the table 1, it is important to understand the chemical activities involved in each process. The chemical activities not only determine the quality and final characteristics of *kapurung*, but also contribute to the nutritional value and sensory characteristics of the product. The following is a discussion of the chemical activities that occur in the making of *kapurung*.

## Protein Denaturation

In making *kapurung* broth, chemical changes occur in proteins called denaturation. Protein denaturation is a process in which the three-dimensional structure of a protein changes due to exposure to high heat, so that the biological function of the protein changes. At temperatures around 55°C to 75°C, the proteins in fish meat, which generally consist of actin, myosin and collagen, begin to lose their folded structures (tertiary and quaternary structures) and change into simpler, unfolded forms (Basuki et al., 2020).

During cooking, these proteins begin to lose their functional properties, such as solubility and elasticity. Initially, proteins in fish have a complex three-dimensional structure due to hydrogen bonds, disulfide bonds and hydrophobic interactions. When the fish is heated, these bonds break and the protein begins to deform. This denaturation causes the protein to become more water-soluble, and some of the protein is released into the broth, giving the broth its rich umami flavor. Therefore, the gravy or broth that is formed contains not only fish juice, but also some soluble protein components, such as amino acids and peptides, which give it a savory taste.

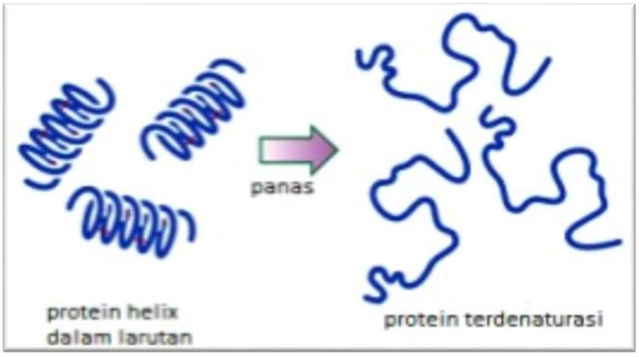


Figure 2. Protein Denaturation
Source: (anakreaksi, 2022)

The denaturation process not only dissolves the protein into the soup, but also changes the texture of the fish meat. The originally elastic fish meat becomes more brittle and easily shreded. At this stage, after the fish is fully cooked, the meat is separated from the soup and shreded to be mixed back into the *kapurung*. Meanwhile, the resulting broth becomes an important base as it contains the fish essence, which acts as the main flavoring agent for the *kapurung* soup.

**Starch Gelatinization**

The processing of sago into *kapurung* uses the starch gelatinization process, which is an important step in turning raw sago starch into a chewy dough. Gelatinization occurs when sago starch, which consists of amylose and amylopectin molecules, hydrates properly when heated with water. The initial gelatinization temperature of sago starch ranges from 70.5- 73.5$^{o}$C, and the peak gelatinization temperature is 76.5-84$^{o}$C (Polnaya et al., 2008). At this temperature, the starch granules begin to absorb water and swell. Higher cooking temperatures and longer cooking times generally lead to a decrease in moisture, protein, and fat content in foods (Wen et al., 2022). As for nutrient reduction during cooking, it can be minimized by steaming or using a microwave (Palermo et al., 2014) (López-Berenguer et al., 2007). In this early stage, sago starch dissolved in cold water has not undergone significant changes. However, when hot water is slowly added and the mixture is stirred, the starch begins to expand and break its intermolecular bonds, allowing the amylose and amylopectin molecules to escape into the solution.

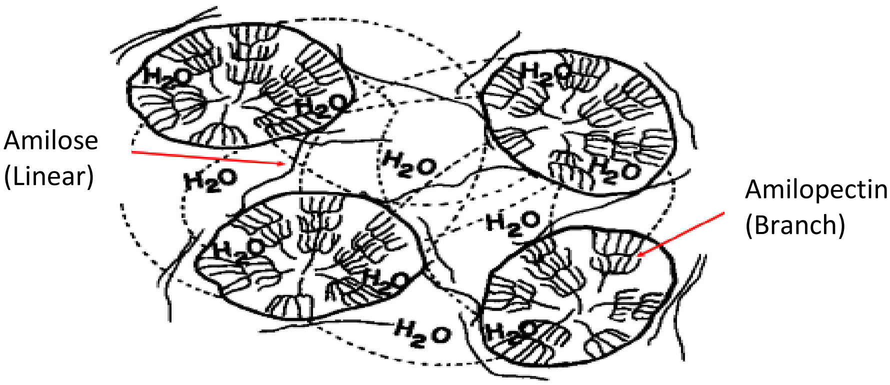


Figure 3. Protein Denaturation
Source: (Xiaojia, 2006)

During stirring with hot water, the development of starch granules that have absorbed water will result in a viscous dough. This process is called gelatinization, and is an irreversible reaction. Water molecules entering the starch granules cause a large development, and at this point, hot water triggers the breakdown of the starch crystal structure, so that the starch turns into a more stable and elastic gel form. This is what causes the sago dough in *kapurung* making to be chewy and sticky.

In this process, amylose molecules provide strength to the gel structure, while amylopectin provides elasticity that allows the *kapurung* dough to be shaped into small rounds. The gelatinization of sago starch is a highly controlled process, involving the interaction between temperature, water and mix that ensures the consistency of the dough. The success of this gelatinization process is key in achieving the perfect texture of *kapurung*, which is chewy yet soft.

In North Luwu, the most common types of sago grown are sago tuni and sago molat (Arsal et al., 2018). Purwani et al. (2006) found that different types of sago have different pasta-forming characteristics. The physical and chemical properties of starch are also generated and influenced by the presence of different amylose and amylopectin ratios in the starch.

Tabel 2. Sago Starch Amylose Content

| Types of Sago | Amylose (%) |
|---|---|
| Lhur | 35,18 |
| Molat | 38,27 |
| Tuni | 37,34 |
| Makanaru | 38,65 |

Source: Polnaya et al., (2008)

According to Kearsley & Dziedzic (1995), amylose and amylopectin content are related to water absorption (rehydration power). Hidayat et al. (2013) stated that the different ratio of amylose and amylopectin in starch can affect the physical and chemical properties of the starch. Starch with high amylose content can absorb water and has a greater ability to expand because it can form larger bonds than amylopectin. In some cases, the amylose content may also affect the gelatinization temperature of starch (Medikasari et al., 2012).

**Fiber Degradation and Nutrient Solubilization**

During the cooking process of vegetables, there is a dissolution and extraction of nutrients that play an important role in the nutritional supplementation of *kapurung* dishes. When vegetables are heated in boiling water, some water-soluble nutrients such as vitamin C and vitamin B complex, as well as minerals such as potassium and magnesium, are released from the vegetable tissue into the cooking liquid. In the process, the hot water breaks down the cell walls of the vegetables, breaking down the fiber and releasing the soluble nutrients (Margareta & Nyman, 2003). As a result, the vegetables taste softer and are easier to digest. In addition, the soup produced by this process is rich in essential nutrients from the vegetables (Sharma & Sharma, 2022).

Extracting nutrients from vegetables also releases important compounds such as antioxidants and flavonoids that provide health benefits. For example, these compounds have anti-inflammatory and antioxidant properties that help protect the body from free radicals. The heating process allows these compounds to dissolve in the water used during cooking, making the *kapurung* more nutritious. However, the duration and temperature of cooking must be considered, as overcooking can result in the loss of some nutrients, especially heat-sensitive vitamins.

Despite the loss of some nutrients during the cooking process, the benefits of the nutrients extracted in the sauce and vegetable flesh remain significant. In addition to providing a richer and tastier flavor, the extraction of these nutrients also makes the *kapurung* sauce more nutritionally balanced. To reduce nutrient loss, some techniques such as cooking for a shorter time or using less water can be applied. Thus, the process of dissolving and extracting nutrients while cooking vegetables contributes greatly to the nutritional quality and overall flavor of *kapurung*.

## Maillard Reaction

The Maillard reaction in fried or grilled fish or chicken is a chemical reaction that occurs between amino acids (from proteins) and reducing sugars when food is heated at high temperatures. This process results in a distinctive brown color as well as complex and delicious aromas and flavors. This reaction usually begins when the temperature reaches about 90°C-130°C (Kchaou et al., 2019). At this stage, proteins from fish or chicken, which contain amino acids, react with the sugars naturally present in the meat to produce a variety of compounds that give it its characteristic roasted flavor and attractive aroma.

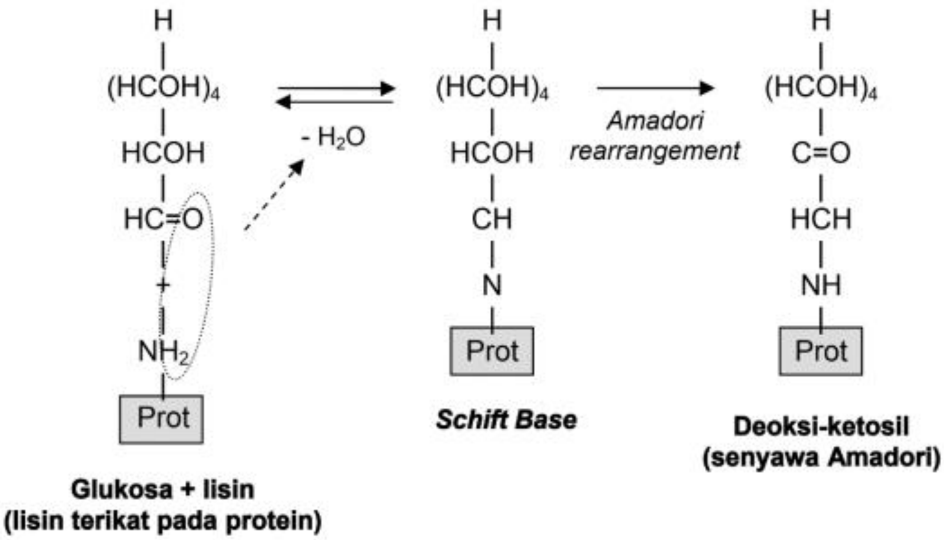


Figure 4. Initial Stage of Maillard Reaction
Source: (Mahanani, 2016)

This reaction causes the aldose sugar to become ketose, forming Amadori compounds (deoxy-ketosyl derivatives). In this condition, the color has not changed, but lysine or other amino acids are damaged, resulting in decreased amino acid availability and decreased protein digestibility.

In the advanced stage, three reaction pathways may occur. The intermediates from these different pathways polarize to form melanoidin, a complex compound that gives food its brown color. In addition, these compounds also play a role in the formation of N-heterocycles, which can affect the flavor, taste, and color of the final product. An important aspect of the Maillard reaction is the formation of melanoidin compounds, which give the surface of fish or chicken a brown color. The longer and higher the heating temperature, the darker the color formed.

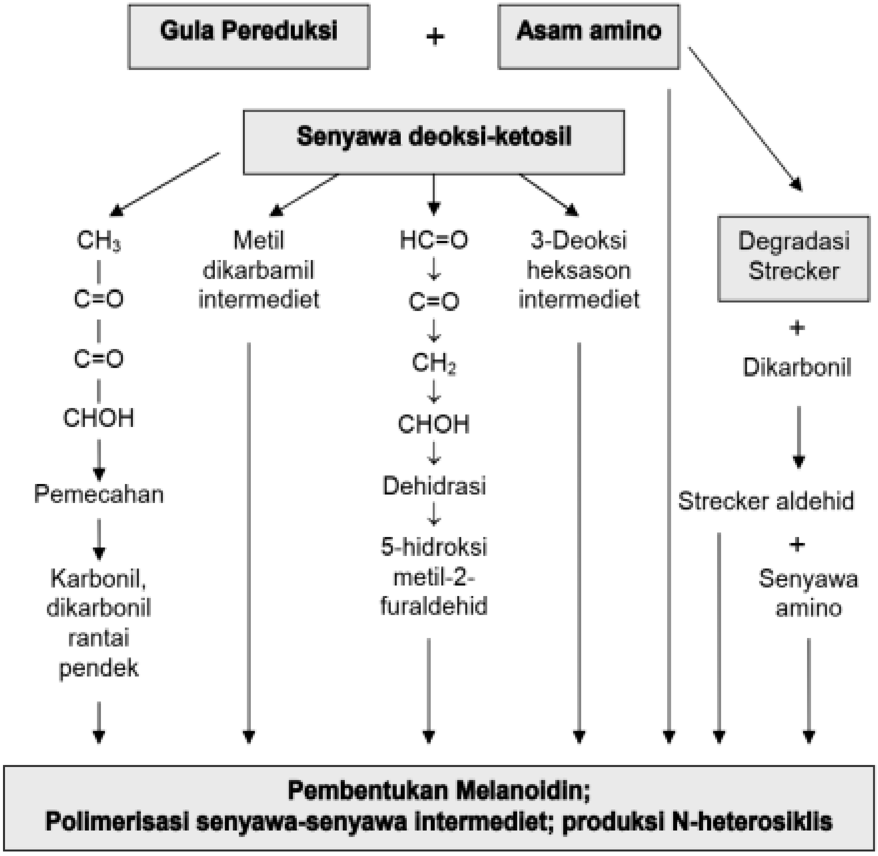


Figure 4. Advanced Stage of Maillard Reaction
Source: (Mahanani, 2016)

However, the Maillard reaction does not only affect taste and color. Nutritionally, this reaction can affect the nutritional value of meat because some of the compounds formed can reduce the bioavailability of proteins. In addition, although this process results in improved flavor, if food is cooked for too long at very high temperatures, potentially harmful compounds such as acrylamide can be formed. Therefore, controlling temperature and time during cooking is essential to maximize flavor and aroma without compromising nutritional quality or food safety.

## Food Additives

The use of food additives in the production of *kapurung* involves natural and simple ingredients that play an important role in creating flavor, texture and increasing the nutritional value of food. The following are the food additives used in making *kapurung*:

1) Acidulant

Lemo Gona and Patikala are used to give a fresh sour taste to *kapurung* sauce. These natural acidifiers help to enhance the overall flavor by balancing the savory flavors of the fish, vegetables, and other ingredients. These acidifiers also serve to maintain the pH of the food so that it does not spoil easily.

2) Flavor enhancers

In *kapurung*, there are several additional ingredients that function as flavor enhancers such as salt, monosodium glutamate (MSG), anchovies/ebi, chili, which function to strengthen the taste of all ingredients. Salt, a natural and synthetic flavor enhancer, accentuates the flavor of the other ingredients. MSG is a flavor enhancer that gives an umami taste. In addition, anchovy / ebi is sometimes added as a source of glutamic acid, which also enhances the umami sensation.

3) Herbs and Spices

Patikala has a distinctive and fresh aroma, as well as a slightly sour and spicy taste that adds flavor complexity to the *kapurung* soup. Its presence provides a unique flavor that is difficult to replace with other ingredients and balances the savory taste of ingredients such as fish/chicken/meat. Chili adds a distinctive spicy flavor to *kapurung*. As a naturally hot ingredient, chili adds a strong flavor sensation to the dish that provides an adjustable level of heat. All of these ingredients add a savory taste to the *kapurung* sauce.

4) Emulsifier

The ingredient that acts as a natural emulsifier in *kapurung* is sago. Sago is the main ingredient in the production of *kapurung* that forms the typical chewy balls. The gelatinization process of sago, which involves the addition of hot water, thickens the starch in sago and produces an elastic texture. As a natural thickener, sago provides the consistency that characterizes *kapurung*. Without sago, the signature chewy texture of this dish would not be achieved.

Other than its high nutritional content, *kapurung* involves several chemical concepts such as gelatinization of sago starch, protein denaturation, fiber degradation and dissolution of nutrients from vegetables, the use of food additives involving acidulants, flavor enhancers, herbs and spices, and natural emulsifiers, as well as the Maillard reaction in fried or baked fish/chicken. Therefore, *kapurung* serves as an ideal platform to better understand the concept of ethnochemistry and apply it to everyday life. This research is expected to contribute to the scientific understanding of chemical interactions in traditional foods, while providing opportunities for innovation in education through the development of curriculum and teaching methods relevant to cultural contexts. This will not only enrich knowledge, but also create a link between science, tradition and the environment.

## CONCLUSION

Based on the results of the study, the concept of food chemistry involved in the process of making *kapurung* is the gelatinization of sago starch, protein denaturation, fiber degradation and dissolution of nutrients from vegetables, the use of food additives, and the Maillard reaction in fried or baked fish/chicken.

## RECOMMENDATIONS

As a follow-up to the research, it is recommended to develop educational materials that integrate ethnochemical concepts with modern chemistry, so that they can be used in formal education for students to better understand the scientific value of local knowledge. In addition, the development of an ethnochemistry-based curriculum or learning module is essential to be used in local culture learning or training so that learners can appreciate the relationship between science and culture. For example, by creating teaching aids for a simple experiment on the starch gelatinization process that occurs when sago is cooked, students can boil sago with water under different conditions (temperature and time) and observe the changes in texture and consistency. This will help them understand the concept of molecular bonding between starch and water. In addition, students can also use simple tools such as nutrient content test kits to analyze the protein, carbohydrate, and fiber content in the ingredients used to make *kapurung*, which can enhance their understanding of food composition. Further research should also be conducted to further explore the chemical processes involved in the production of *kapurung*, for example by studying the effect of specific ingredients or processing methods on the chemical composition and nutritional value of *kapurung*,

## ACKNOWLEDGEMENTS

Thanks to the Rector of IAIN Parepare, the Chairman of LPPM IAIN Parepare, Colleagues in Tadris IPA Faculty of Tarbiyah who provided support and facilitated the completion of this research. The people of Meli Village, Baebunta District, North Luwu Regency for providing the opportunity to conduct research. The research team who have dedicated their time and energy in conducting this research.

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