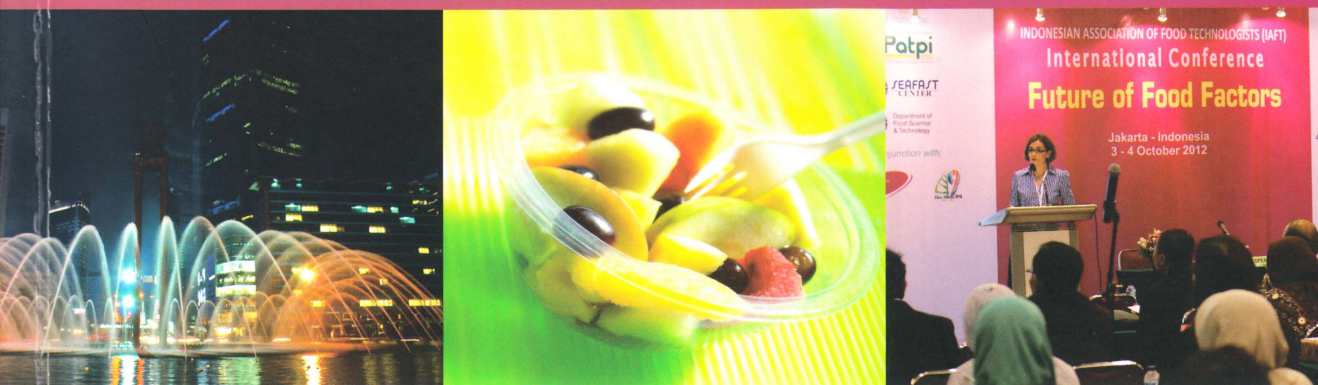# Proceeding

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Food Product Development as a Food Factor: Lesson Learned from the Development of Corn Noodle Processing Technology

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ABSTRACT

This paper presents our experience in conducting research and development (R&D) of corn noodles. The R&D process covered the steps of product concept generation, formulation and processing development to obtain noodle prototype, process scaling up and commercialization. A lot of factors to be considered in R&D process of corn noodles, such as consumer perception and expectation, characteristics and availability of raw materials, processing condition and steps, existing noodle technology for scaling up and technology commercialization. It is known that wheat noodle has become a part of Indonesian diet, which results in a high consumption of wheat four. Corn flour is potentially used as an alternative raw material in the production of corn noodle. However, the low content and different characteristics of gluten protein in corn flour caused the difficulties to produce elastic corn dough and noodle. Hence, the processing technology of corn noodle from 100% corn flour could not adopt the existing processing technology of sheeted wheat noodle. The formation of elastic and compact dough could be reached by gelatinized (steamed) partially the formulated corn flour before dough forming, sheeting and slitting. To completely cook the corn noodles, the wet corn noodle is then steamed before drying. Extrusion technology is another promising technology to produce 100% corn noodle. The formulated corn flour is initially steamed to gelatinize partially the corn flour, and then extruded by multi-function noodle machine, steamed and dried. Corn flour could also be used as substitute flour up to 25% in the production of sheeted wheat noodle without modifying the sheet processing technology.

Keywords: *Research and development, corn noodle, noodle prototype, food factors*

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R&D Process in Corn Noodle Technology: from Concept to Product

The Department of Food Science and Technology and SEAFAST Center IPB has developed the processing technology of corn noodle through a series of research and development process (Anonym, 2005). The development of corn noodle processing technology followed several stages, starting from product concept generation, translating the product concept into a product model (protocept), expands the protocept into a prototype that has been trialed at a larger scale production, and the initiation of technology commercialization to potential users. Table 1 summarizes the activities in the steps of corn noodle technology development from the product concept into a commercial product.

There are several reasons underlying the concept development of corn noodles as follows: (1) To reduce dependence on imported wheat flour by utilizing local carbohydrate resources, including corn; (2) increase the added value of local-based commodities by developing food products that have potential economic impact; (3) the developed technology is expected adoptable by different segments of food industries (small, medium or large scale food industries).

Table 1. Steps in research and development of corn noodle technology from a concept to a commercial product

Product Concept	Protocept Development	Prototype Development	Commercialization
• Defined expected product profile (such as 100% corn flour, natural food colorant, rich in beta carotene and dietary fiber, instantly cooked, low glycemic index, etc)	• Select corn varieties and characterization • Formula & process development • Evaluating product qualities & functionality	• Process verification at a pilot plant scale • Identify critical process: scale independent parameter • Product stability (shelf-life) • Product application in culinary food products	• Business plan • Production trial • Technology dissemination • Product promotion • Marketing trial

Noodle has been well known and has become part of Indonesian diet so it is potentially used as a vehicle in food diversification program. Juniawati (2003) conducted a survey to obtain consumers' perceptions of non-rice food products. The survey indicated that noodle was most liked by consumers' compared to other food products. Non-rice products were mainly consumed for breakfast or as a snack (Figure 1). Unfortunately, the main ingredient of noodle is wheat flour. The idea is how the noodle can be processed from other flours that are locally available. Corn is one of important agricultural commodities in Indonesia that is potentially used as as a substitute ingredient in noodle. Therefore, utilization of corn flour in noodle is expected to reduce the dependence on imported wheat flour.
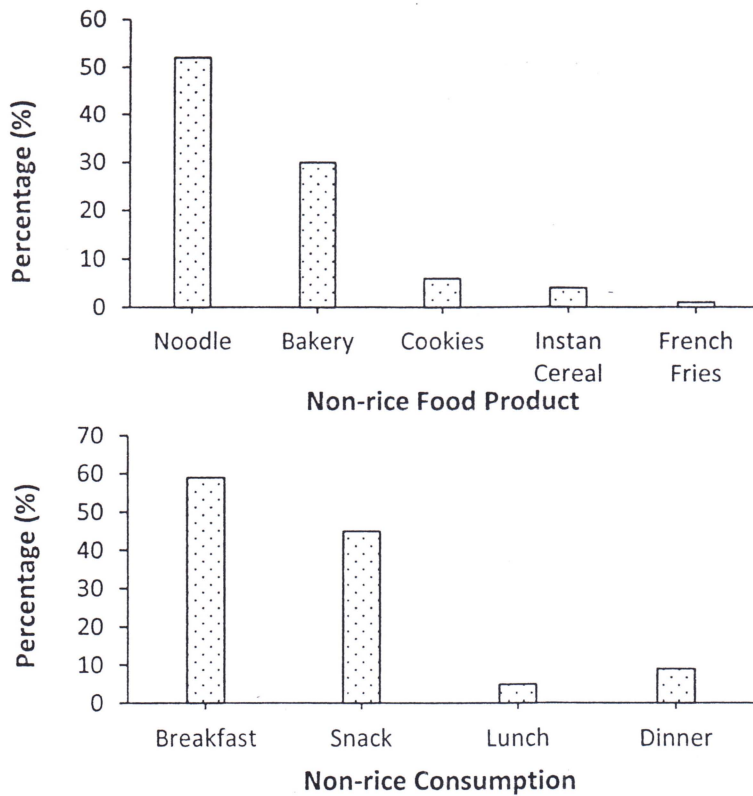

Figure 1.   The consumer's perception of non-rice products (Juniawati, 2003)

The initial product concept of the corn noodle product is defined as follows: The corn noodle is composed of 100% corn flour or as a substitute in noodle formula, adopting existing noodle technology, the corn noodle has a

similar quality characteristics to wheat based noodle (such as low cooking loss, elastic, instant, and long shelf-life), have good functionality, such as usage of natural colorants, rich in beta carotene and dietary fiber, and low glycemic index. This product concept was then realized into protocept through series of research and development activities. Modification of the initial concept might occur in the following step due to technical constrains.

The main problem in the development of corn noodle is the different characteristics of corn flour compared to wheat flour (White and Johnson, 2003). Corn flour is lack of gluten protein responsible to elastic texture of dough and noodle. For this reason, the initial concept of corn noodle processing technology was modified. The elastic dough of corn flour cannot be formed by applying existing sheeting technology for wheat noodles (Merdiyati, 2008). The existing sheeting technology can only be used to process substituted corn noodle (25-30% corn flour). Modification process was made to produce 100% corn flour noodle, by adding the step of starch gelatinization process before sheeting and slitting (Putra, 2008). The degree of starch gelatinization is a critical process in forming elastic and compact dough. Another alternative processing technology is by adopting extrusion technology as applied to vermicelli or glass noodles technology. The corn flour is firstly steamed to gelatinize corn starch, then passed into the extruder to form strands elastic noodles (Muhandri and Subarna, 2009). The wet noodle can be dried into dried noodles or fried in cooking oil to form instant noodles. As a summary, corn noodle technology (100% corn flour or as substitute) can be described as follow (Figure 2). The processing step of each corn noodle technology is presented in Figure 3.
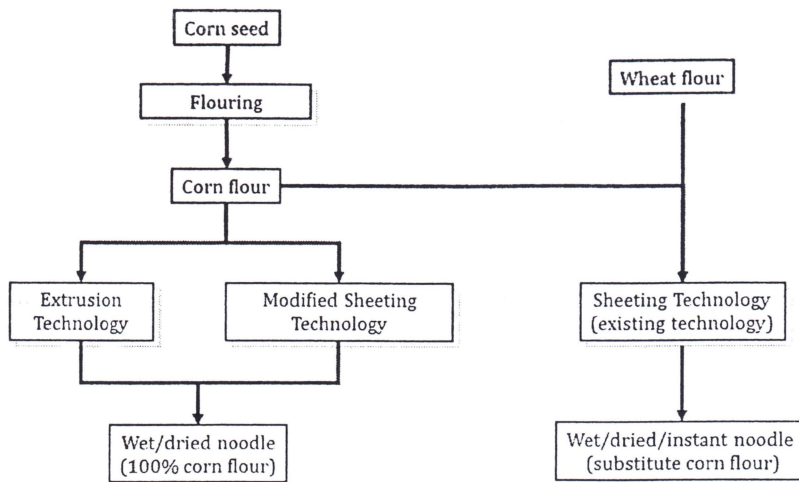
Figure 2. The concept of corn noodle processing technology (Kusnandar et al, 2008)
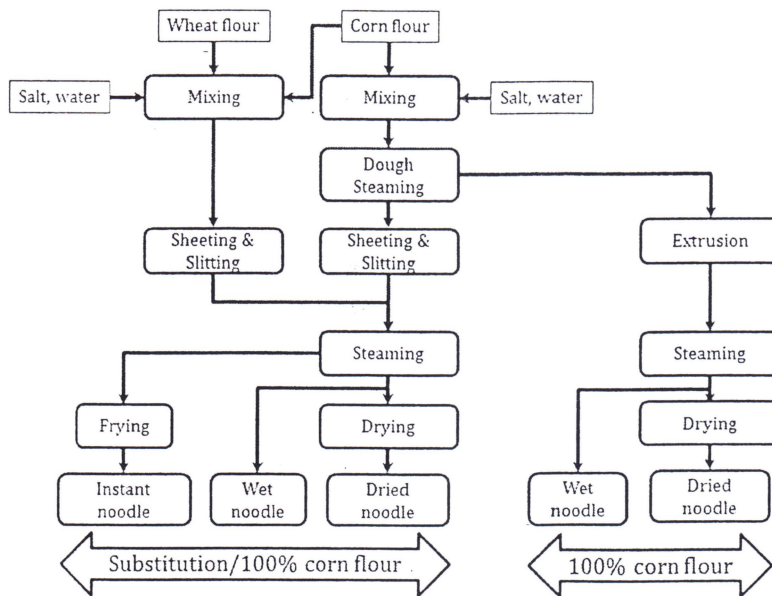

Figure 3. Flow process of different corn noodle technology (100% corn flour or as substitute) (Kusnandar et al, 2008)

The corn noodle produced by above sheeting and extrusion technology has slight different cooking loss and elasticity. Overall, the wet noodles have more elastic than that of dried corn noodles (Table 1).

Table 1. Cooking loss and elasticity of corn noodle produced by sheeting and extrusion technology (Kusnandar et al, 2008)

Noodles	Technology	Cooking Loss (%)	Elasticity
Dried wheat noodle	Sheeting	4.6	Elastic
Wet corn noodle	Sheeting	5.7	Elastic
Wet corn noodle	Extrusion	5.5	Elastic
Dried corn noodle	Sheeting	8.2	Less elastic
Dried corn noodle	Extrusion	7.5	Less elastic
Substituted corn noodle (25%)	Sheeting	5.5	Elastic

Technology Commercialization Process: from Prototype to Launched Product

There are various corn noodle technology developed, i.e. wet corn noodles, dried noodles and instant corn noodles, either by using existing sheeting technologies, modified sheeting technology or extrusion technology. Table 2 shows the potential of the technology adoption of corn noodles. Wet corn noodle is mainly adoptable by small or medium-sized industries, dried corn noodles is adoptable by medium or large industries, while corn instant noodles is potentially adoptable by large scale industries. Dried or instant corn noodles require a larger investment than a wet noodle. Among these technologies, the wet and dried noodles using extrusion technology are easily adoptable due to more simple technology and lower investment.

The introduction of the corn noodle application into processed products is also important steps in a commercialization process. Based on the trials that have been conducted, corn noodles can be used for a variety of culinary food products as seen in Table 3. The consumers testing for example food products are presented in Table 4. In general, consumers accepted sensorically the corn noodle based food products.

Table 2. Potential adoption of corn noodle technology by different segment of food industry (Kusnandar et al, 2008)

Corn Noodle Technology	Technology	Raw Material	Potential User
Wet corn noodle	Extrusion/ sheeting	100% corn flour	Household, small scale industry
Dried corn noodle	Extrusion	100% corn flour	Medium and large scale industry
Wet corn noodle	Sheeting	25-30% corn flour	Household, small scale industry
Dried and instant corn noodle	Sheeting	25-30% corn flour	Medium and large scale industry

Table 3. Potential application of corn noodles in food products (Kusnandar et al, 2008)

Type of Noodle	Noodle Based Product
Substituted corn noodle	Mie goreng, mie bakso, noodle snack, etc
Wet corn noodle 100%	Soto mi, mi ayam, fried noodle
Dried corn noodle 100%	I fu mi, spaghetti, pizza

Table 4. Percentage of consumer acceptance of corn noodle based food products

Consumer Acceptance	Meat Ball Noodle (%)	Chicken Noodle (%)
Extremely liked	3.2	18.8
Liked	39.7	50.7
Slightly liked	19.0	7.2
Neutral	38.1	18.8
Slightly disliked	-	2.9
Disliked	-	1.4
Extremely disliked	-	-

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Obstacles in Technology Adoption

Technology adoption is the most difficult stage in the development of corn noodles. It must be able to convince businesses that the technology developed has a prospective market and acceptable by consumers. For utilization of existing technologies, the failure risk is relatively small because it simply changes the raw materials from wheat flour to corn flour. When required a new technology, for example by adopting a modified sheeting technology by adding steaming process before sheeting and slitting process, it would certainly become food industry consideration before decision is made.

It is often questioned what the selling point of corn noodle compared to wheat noodle. It means that product positioning is very important for a new product. Research to explore the functionality of corn noodles compared to wheat noodles is important, such as beta carotene and dietary fiber content and a lower glycemic index. In addition, the availability of raw materials, particularly corn flour, becomes very important. Corn flour industry has not been well established, so it will become a problem for small industries that cannot be self-supply of corn flour.

LESSON LEARNED

There are some lessons learned that can be derived from corn noodle technology research and development process as follows:

1. The R&D process of corn noodles needs to consider raw material characteristics that cause the processing technology modification, technology availability (it must consider for faster technology adoption), and product positioning compared to similar products.

2. It is important to note that not all product concepts defined at initial step can be fulfilled into prototype. A compromistic with technology constraint should be made to make the concept be more realistic.

3. A small problem in a laboratory scale may become a serious problem in a commercial scale production. Steaming and sheeting process are critical step that must be considered during scaling up process. The technological constrain may slow down the technology adoption.

4. The technology commercialization process is the most difficult step. Product positioning compared to wheat noodles and support of

government policy are very important to accelerate the technology commercialization.

5. In a short time, wet corn noodles using extrusion technology (for 100% corn flour) and sheeting technology (for substitute corn flour) are most feasibly adopted by small-medium scale noodle industries. The critical point is the availability and price of a corn flour and selling point of the product compared to existing noodle product.

6. To accelerate adoption in a large industry, it is important to link and match between R&D activities in university and industry business plan/strategy. The university and industry must have the same interest and objectives of the potential technology.

ACKNOWLEDGEMENTS

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