

# Technology Development of Kupang Processing with Dryer Machine Base on Expert System

Dedin F.Rosida<sup>1</sup> and Dedid Cahya Happyanto<sup>2</sup>

*Abstract—Kupang as one of traditional food in East Java is an asset that has a positive impact on the nutritional status and health of those who consume them. Efforts to accelerate the realization of the preservation movement kupang through "I love Indonesian food" can be done in addition to providing information support for scientific study and rational accurate about the benefits and safety of those who consume should be developed kupang sale value processed products. Of nutritional aspects in addition to a high protein, apparently in mussels also contained the unsaturated fatty acid chain length is relatively high for good health. Kupang-based optimization of food processing is desirable. Balonggabus village of Candi Sidoarjo District is a regional producer of mussels and the potential to continue to develop products using a variety of mussels to the processed form of dryer machine (cabinet dryer) based on expert system so that the resulting product would be great texture, aroma and taste. Various processed mussels that can be developed such as: instant kupang paste, Kupang flour, Kupang crackers, noodles mussels, mussels etc so that products become more durable. This will make the area Balonggabus be more independent in producing and increasing revenue.*

*Keywords—Kupang, Processing Technology, Cabinet Dryer, Expert System.*

## I. INTRODUCTION

Green mussel (*Perna viridis*) is one kind of shellfish popular community, have economic and nutritional value are very good to eat, which is composed of 40.8 % water, 21.9 % protein, 14.5 % fat, 18.5 % carbohydrate and 4.3 % ash making mussels comparable to beef, eggs and chicken meat, 100 grams of green mussel meat contains 100 calories (Ministry of Maritime Affairs and Fisheries, 2008).

Production of mussels in the area of Sidoarjo East Java, especially between 8.5404 million to 8.6753 million kg per year (Prayitno and Susanto 2001). Kupang as one of the assets of traditional food in East Java who allegedly had a positive impact on the nutritional status and health of those who consume them. In addition, as part of the cultural heritage of the ancestral work, it needs to be preserved.

As is known, from the nutritional aspect besides containing high protein, apparently in mussels also contained the unsaturated fatty acid chain length is relatively high. Animal fat as one of the basic components that are beneficial to health, one of which is unsaturated fatty acid content of long-chain could contribute to tackling hypercholesterolemia. The presence of unsaturated fatty acids as well as its ability to act as an antioxidant, will also stimulate cholesterol excretion into the intestine, and also stimulates the oxidation of cholesterol from unsaturated fatty acids more easily metabolized by the liver, so it can increase excretion. And the magnitude of the potential health benefits of these mussels would be nice if it was developed into a variety of products that much more.

That there are objective conditions of low productivity-based processed food kupang caused by weak due to lack of human resources and information technology mastery, and the poor quality of entrepreneurial business

people. Issues of human resource development and productivity further complicated because most micro businesses with less facilitated access to information, technology and innovation. To the importance of product diversification mussels need to be explored further so that more people-based foods like mussels. To improve product quality mussels is needed diversification of production machinery in this case to produce flour paste kupang as materials kupang. One of the required machinery is kupang flour dryer with LPG heaters that use control techniques based on expert system.

## II. METHOD

Efforts to accelerate the realization of mussels can be done preservation movement than with providing information support of scientific study and rational accurate about the benefits and security for consuming. Methods that can be done is by the method of approach is to facilitate the improvement of the skills of fishermen and businessmen of refined kupang's products in the village Balonggabus Candi Sidoarjo district to conduct training. Methods of training include :

- a. Lecture method is the provision of basic theory in the processing of food products that are innovative, durable, safe, high nutritional value and can be made public as well as having economic value added.
- b. Practice methods of providing training that focused on the ability of community skills in innovative product processing. This training emphasizes the active participation of the participants.

Methods of assistance for sustainable business activities.

Training materials generally include understanding the theory and entrepreneur skills capability in processing mussels into processed food products, Among others :

- a. Preparation of mussels into refined products are safe and can be reduced metal contamination contained in Kupang
- b. Based food processing various kupang :
  - i. Making kupang flour as raw materials of various products such as : biscuits and sticks kupang,
  - ii. Petis instant kupang
  - iii. Dried noodles kupang
  - iv. Jerky restructuring kupang

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In the manufacture of various food products based on the required kupang dryers that use specific time and temperature can be set so that it will produce good food and good quality in terms of nutrition and appearance. Differences in temperature due to the use of each type of product used to produce a certain temperature crispness with nice quality. For that use a dryer based on expert system. Expert system that applied this dryer is imitating the engine manually performed by a kupang's paste expert. The steps undertaken by interviewing an expert kupang's paste to gain basic knowledge of an expert manufacturer and kupang's paste for all the problem and its solution. This knowledge will be combined with the configuration of the device used, for example the problem of sensors, actuators and so on to build an expert system accordingly. Given the process of moving from an expert knowledge into the system and perhaps the discrepancy of the device used, the testing and evaluation of an expert system that has been created. The evaluation results confirmed turning to an expert and is also used to improve the system configuration used. Expert system includes several aspects, namely :

#### 1) Knowledge Base

- a. Part of the expert system that contains the domain knowledge, ie the knowledge needed to understand, formulate and solve problems.
- b. Consists of two basic elements :  
Facts, circumstances and issues related theory
- c. Specific heuristics or rules, which directly uses knowledge to solve specific problems.

#### 2) Working Memory

Part of the expert system that contains the facts of the matter are found in a session , that the facts about the problems found in the consultation process

#### 3) Inference Engine - Intelligent Machines

Processor on an expert system matches facts that exist in the working memory domain knowledge contained in the knowledge base, to draw conclusions from the problems encountered. Human thought process is modeled in an expert system on module called Inference Engine.

Expert System structure described above is shown in Figure 1 and the diagram Decision Expert System is described in Figure 2 below.

Expert systems are made can not be separated from the way a person thinks Kupang paste maker expert who is later revealed in the form of decision diagrams. Of the decision diagram is an expert system that will be built accordingly, as shown in figure 3.

### III. RESULT AND DISCUSSION

Kupang can serve a variety of products such as dried noodles mussels, mussels and kupang's instant flour paste, which can later be developed into a variety of snacks or biscuits. The selection of products is intended for products produced kupang more durable and still enough nutrients to survive. So far, only mussels mussels and rice cake made into a paste which is power shelf kupang relatively short. Kupang flour products, Kupang biscuits, dried noodles instant mussels mussels and paste the final stage of processing requires proper drying process for each product. This meant that the quality of the product is quite good in addition to the nutritional quality can still be retained.

The main principle of drying is the water discharge of the material due to heat transfer processes related to the temperature difference between the surface of the product to the surface of the water at several locations in the product. Size of the material to be dried can affect the speed of the drying time. The smaller size of the material, the faster drying time. This is due to the small size of the material has a large surface area so as to facilitate the evaporation of water from the material (Wirakartakusumah et al. , 1992).

Drying is also defined as the process of taking water from a relatively small solid or gas mixture . Drying occurs by operation of the heat, to be distinguished by the separation of a mixture of water density that occurs physically operating the evaporation. Evaporation is taking water with a relatively large amount of an aqueous solution of concentrated (Pramudono and Bambang 1988). Two kinds of drying are known : (1) Natural Drying Drying is natural to use in direct sunlight, (2) Artificial Drying Drying is made by media using steam or hot air heating. In addition, known also three kinds of drying process if the terms of the process, namely : drying with hot air at atmospheric pressure ; make air drying with vacuum, Drying freeze drying. In the selection of dryers to be used depends on several factors, namely :

(1) Form of the material to be dried : granules (granular) or sheet; (2) Types of dryers: batch or continuous; (3) How to contact the air (gas) with the material to be dried tailored to the type and shape tools. (4) Properties of the material to be dried : no tau resistant to high temperatures ;(5) Caharakteristic of resistant materials or contamina-tion, usually between the air contact with the material can be directly or indirectly (Pramudono, Bambang 1988).

#### A. Kupang flour

Flour-making process is quite simple and can be done in the home, as well as small industries. Kupang after reduction of metal content and leaching was put in the dryer and then carried out the destruction and sieving. Drying is a way to reduce the moisture content of a material, in order to obtain the final result is dry. Drying aims to extend the shelf life of food. Drying is a process of heat transfer and moved past. Heat transfer takes place through a solid surface, where the heat is transferred to the material through the metal plate heater. Furthermore the material out of water and evaporated. Basically a water evaporation material varies according to the heat flow. Drying will be more effective in a controlled airflow. There are two ways for this kind of material is used for example in the form of solids or plate the appropriate tool to dry the material is dryer cabinet or tray drier As for the material in the form of a paste or puree the appropriate tool is the dryer drum to dry. Dryer with a continuous system using a spray drier, Tunner drier, rotary drum drier and drier.

There are two ways of drying are commonly used in the food drying with drying and drying with a dryer in the drying process is generally done by the sun.

There are two advantages of drying in the sun, namely the power of bleach because the ultra violet rays of the sun and reduce chemical degradation which can degrade the quality of the material. The weakness can be

contaminated by dust that can reduce the degree of whiteness of flour.

In the drying process often arise various problems such as the difficulty of controlling temperature and humidity, microbial contamination, and the dependence on local weather conditions. Artificial drying with a dryer will get the results as expected as long as the condition can be controlled with good hair. Generally drying using a dryer is faster than the drying and can better maintain the color of dried materials. Type of material to be dried, the dried end product quality and economic considerations influence the selection of tools and dryer conditions that will be generated.

The best method of drying is a method that is not expensive and can produce quality, as well as the characteristics of the desired product. So that dry food can be accepted by consumers, the price must be competitive with the various types of durable good food, have a taste, smell, and appearance which is proportional to the product - fresh product or products - products are processed in a different way, can be easily reconstituted, still has a high nutritional value and should have good storage stability. Dryer Cabinet consists of a room that is well insulated to prevent heat loss. For commercial use of the heat source can be derived from electricity or gas. Cabinet dryers are generally used for food commodities with airflow velocity 500 -1000 ft / min . Drying will take 5-10 hours or less depending on the type of material and the desired level of moisture content. Material to be dried can be placed on a tray or baking sheet with holes as a thin layer. At large cabinet dryer trays placed on trolley for easy handling. For a small size can be put on a permanent crutch. Fan or blower which is in the cabinet dryer air flow through the heating elements and spread it evenly over trays containing the material to be dried. This dryer features an air duct to drain filled with water vapor prior to recirculation.

#### B. Kupang biscuits

According to Winarno, et. al (1984 ), reducing the water content of the foodstuff foodstuffs will contain compounds such as proteins, carbohydrates, fats and minerals in higher concentrations. However, the vitamins and dyes in general becomes damaged or reduced. If the drying process is carried out at high temperatures, then this could result in a " case hardening " is a condition where the outer part ( surface ) of the material is dry yamg while the inside is still wet. This is because the drying temperature is too high will lead to the surface quickly dries and becomes hard, thus inhibiting the subsequent evaporation of the water contained in the food.

Oven is a cooking stage to get the biscuit biscuits were overcooked. Biscuits baked in a hot oven to determine the shape, flavor, and color of the resulting biscuits . At biscuit processing for large industry, having made biscuit dough, biscuits which were printed in print belt mesh is transferred to the oven, and the biscuits into the oven chamber consisting of 4 parts. Wind pressure on the blower and blower down in the oven about 4 kPa. Oven alarm will sound if there is an error in the system. Here are the details of the parts in the industrial biscuit oven large scale :

a. Part 1 is the stage of the formation of structure biscuit:

- Above temperature 200oC - 220 ° C
  - Lower temperature 200oC - 210oC
- b. Part 2 is a development stage biscuits :
- Temperature Above 210oC - 230oC
  - Lower temperature 210oC - 220°C
- c. Part 3 is the stage of maturation biscuits .
- Above temperature 210oC - 220°C
  - Lower temperature 200oC - 210oC
- d. Part 4 is a stabilization phase in order to obtain biscuits really matured both the inside and outside of the biscuits :
- Temperature Above 180oC - 200oC
  - Lower temperature 100oC - 110oC

Drying process lasted for 6 minutes. For one batch total oven time is 21 minutes 30 seconds. Checking the water level every final stages of oven. Standard moisture content of biscuits coming out of oven machine is 3 %, but in fact the biscuit moisture content ranged from 1.8 to 5 %. Engine capacity of 464 kg/21 oven, 5 minutes. Within an hour produced 1295 kg / hour biscuits cooked. Bottle neck process lies in the stage production of biscuit oven, because the equipment is relatively small capacity and relatively long process time (Yulianingsih 2007).

#### C. Dried noodles Kupang

Best dry noodles sightings obtained by drying molen dryer, this is due to the hot air exhaled temperature is not too hot [ + 60oC-70oC ], the temperature can be constant, not fluctuating. Unlike the gas oven dryers, where temperature stability is not guaranteed due to the limited ability of the tool where there is no temperature stabilizer. In the oven tools, although at the beginning of the process, the heating temperature is set around 60 - 70oC, but the way gas oven temperature can be much higher than the temperature. Oven temperature control can only be done by open/ close the oven door. This resulted mussels noodles resulting color is not uniform (Sarastani).

Noodle quality is determined by process conditions. Therefore, the determination of the parameters on each part of the process is considered critical to be done to improve the process on a large scale such as the type and duration of stirring mixer when mixing the dough, the temperature and the duration of steaming, temperature and long noodle sheet formation, as well as the optimum drying temperature and time in the oven. According to Astawan (2005 ), the mixing process aims to hydrate the flour with water to produce a homogeneous mixture. Good dough can be made with regard to the amount of water added (typically 28%-38 % of the weight of flour), mixing old (about 15-25 minutes), and the temperature of the dough which can be affected by the friction between the batter and stir. In the steaming process occurs where the starch gelatinization starch granules will swell because the water molecules penetrate into the granule and trapped molecules at the composition of amylose and amylopectin to produce a cohesive mass of dough is quite elastic and when mixing. In addition, starch gelatinization can also cause surface melting to form a thin layer of noodles (film) which can give softness to the noodles and improving the digestibility of starch and rehydration noodles. Long steaming time may vary depending on the amount of batter and cooked

products, but the level of gelatinization or cooking expected about the same.

In the sheet forming process, the dough is passed repeatedly between two metal rollers that will transform the dough into a sheet. Factors that influence this process are the temperature and the distance between the rollers to obtain the desired thickness of the sheet. The next printed sheet is thin noodles into strands of noodles with noodle roll printer (slitter). Noodles that have been printed and put in the oven to dry completely so that makes the product dry and crisp (11%-12 % moisture content). Factors that influence this process is temperature and pressure (Astawan, 2005).

Using the oven drying rehydration affect the rate of water on the product. According to Hou and Kruk (1998), noodles drying process can be done by using hot air (ovens), frying (deep frying), or vacuum drying (vacuum drying). Oven comes with a tray to put the noodles to be drained, tray used has a lot of holes in the bottom to keep the heat be on the bottom of the dried product. Energy sources such as hot air drying results from the conversion of heat steam boiler that takes place in the radiator. Hot air intake process through the holes in the wall oven. To flatten the heat, the oven is also equipped with a blower.

On dried noodle products on dough that has been steamed and then put in the oven to dry completely (11-12 % moisture content), and making the product dry and crisp. Drying process is carried out at a temperature of 55oC–60oC for (1-1.5) hours. Drying is considered sufficient if the noodles easily broken and no longer stick to the tray. Production based to a scale of 1 kg, the yield of dried noodle products produced by 74.53% (986.29 g). Drying with hot air from the oven too soon can cause dry noodles become brittle. Therefore, it is necessary to control the temperature and relative humidity in the drying oven. Long drying time will also determine the characteristics of the final product. If the drying time is too long, dry noodles become brittle. This of course will affect the cooking quality of the dried noodles because when cooked noodles to be broken and it can also increase the cooking loss were characterized by turbidity water color cooking noodles. Instant noodle can obtained by drying has a low fat content and longer shelf life as well as not related to rancidity due to less fat in the product. In addition to a longer shelf life, some of the advantages of the drying process, among others, the volume of the material becomes smaller making it easier and saves space transport and packaging, as well as products to be lighter so that transport costs become smaller. But there are also disadvantages of the drying process, including the changing nature of the origin of the product (Mardiyanti 2008).

#### *D. Kupang's paste instant*

Food products desired by modern society not only consider the elements of nutrition, but also have a practical, fast, durable and require no space or more storage space. Therefore, the current consumer trend leads to products that highlight the nature of the fast (instant) in addition to nutritional value. Fast food product powder (instant) is a food product in the form of powder, crumb structure, easily dissolved in cold water and hot water, easily in the presentation, easily dispersed and not settle to the bottom of the container (Desrosier,

1988 ; Wirakartakusuma et al, 1992 ). Making fast powder ( instant powder ) can be done with high technology using advanced tools such as freeze dryer and spray dryer, but these tools are quite expensive and not affordable by farmers groups and home industries. Mussels paste can be processed into powder or paste paste kupang kupang instant. The second type of product is certainly different in preparasinya process, drying and dissolution properties.

One technology that can replace the spray drying is the technology foam mat drying. This technology is simple and can be applied at home industry level. Foam mat drying is a technique of drying the product is a liquid and sensitive to heat through foaming technique by adding substances pembuih (Kumalaningsih, et al, 2005). Drying oven without pembuih (foam) requires a high temperature, so it will damage the quality of food products are dried (Desrosier, 1988). Drying is the reduction of the moisture content of materials to spoilage bacteria can not survive and the damage can be reduced.

The drying process is not always water in the material derived low as possible, but to below the aw value (water available) minimum. Each microorganism requires minimum Aw different, ranging from 0.60 to 0.91. Basically a lot of food that can be processed into instant powder. That's different, if the commodity to be made instantly very hygroscopic and contain highly sensitive nutritional components, such as pumpkin. Pumpkin if it will be made into a fine powder to use technology Vacuum Tray Dryer. Vacuum Tray Dryer is basically a tray dryer is operated at a lower pressure of 1 atm. This dryer is used when the dry ingredients quickly and maintained low temperature materials. Vacuum Tray Dryer consists of a cover (sheel) terbuat of cast iron, usually rectangular cross section and composed inside a tray to put the material to be dried. The trays inside hollow and filled with media operations during the heating steam or hot water. At the front of the dryer on both sides there are two vertical fan and a short pipe connecting one vertical pipes used for heating media include water vapor, while the other vertical pipe to accommodate condensate occurring and to remove gases can not condense (non gas condensate). This dryer is used to dry the material both rapidly and maintained low temperature materials. This type of dryer is used for materials that are not resistant to high temperatures such as pumpkin fruit. Material to be dried is placed on the trays, dryer should be sealed and in the drier parts of the pressure created by the vacuum created using the help of a vacuum pump. Water vapor in the cavity tray slowly heats the material will evaporate the water and that of the material at a temperature corresponding to the level of kevacuuman in the dryer. This evaporated water is condensed at the condenser which is located between the dryer and the vacuum pump drier. This type is used for materials that are not resistant to high temperatures such as pumpkin fruit. These advantages are very useful in the production of food ingredients powder form.

In this process easily degraded thermal component is protein,  $\beta$ -carotene, vitamin A and vitamin C from the pumpkin. If the food that will be made in the form of sweet potato powder instant it can use the drier type fluidized bed drier or oven cabinet, but both of these tools is based on parameters of water absorption index

(percent rehydration), the use of a fluidized bed dryer type is more appropriate or suitable for produce high rehydration percent (537.33 to 535.01 %), compared to drier types Oven Cabinet (Paisey 2011)

#### E. Equipment Type Fluidized Bed Dryer

To realize a dryer that has a water absorption index parameters that produce high rehydration then constructed Fluidized Bed drier type, with work on the system block diagram as shown in Figure 3 which includes :

- The hardware used in this system include the latest AT89C51, temperature sensor (thermocouple), ac motors as drive blower.
- Microcontroller as input data processor that makes the data output to the motor and regulator control valve heating with LPG gas.
- Keypad to input set points.
- LCD as a display device.

And built a machine that includes space Oven, Stove LPG and Control Valves, Blowers, Temperature Control and Sensor temperature, Control Panel, System electrical safety, is shown in Figure 4 and control panel in figure 5.

So that the dryer has a high factor of safety against electric shock hazard that could endanger users machine, then this machine is installed with the electrical safety system Earth Leakage Circuit Breaker (ELCB) is shown in Figure 6, with a safety factor specification as follows :

- Protection against direct touch GPAs of 30 mA
- Protection against indirect touch GPAs Not 300 mA
- Protection against fire GPAs of 500 mA.

#### F. Testing tool Cabinet Dryer

##### 1) Biscuits Kupang

Which is the stage of ripening oven biscuits to get the biscuits were overcooked. Baked biscuits on the baking sheet in a hot oven for determining the shape, flavor, and color of the resulting biscuits. On the processing of biscuits, after biscuit dough is made, which is above the printed biscuits and biscuits are baking sheet into the oven chamber consisting of 4 parts.

- Stage 1 is the stage of a biscuit structure formation
- Stage 2 is the stage of development of biscuits
- Stage 3 is the stage of maturation biscuits.
- Stage 4 is the stage of stabilization in order to obtain biscuits really matured both the inside and outside of biscuits

The length of the process depends on the amount of material oven dried. Approximate drying time is needed on a range of materials biscuits kupang 1295 kg with a length of approximately 60 minutes. Tests were conducted in this study using the dryer cabinet with size dimensions : H x L x D = 100 cm x 120 cm x 60 cm. Material is placed on the pan of biscuits mussels are made of thin steel.

With a note :

- T - High,
- L - width
- D – depth

The test results for material drying machine biscuit kupang shown in the Table 1. Drying of the test results as shown in Table 1 above followed by measurement of water content (WC), using the calculation :

$$WC = \left( \frac{\text{initial weight} - \text{weight after drying}}{\text{initial weight}} \right) \times 100 \%$$

From the results of the calculations indicate that the water content of 3.4 % . This approach is in accordance with the required 3 %.

##### 2) Kupang paste

Mussels paste product is a product that does not last long. Paste products can only survive for about three days. Paste mussels are easily contaminated by microbes mildew / mold. For the paste product will last longer if made into an instant product. For instant product can be done with the drying process. If done with proper drying process then paste mussels can last more than one month. To perform the test making instant kupang paste, as in figure 7 below.

#### IV. CONCLUSION

- Kupang biscuits, dried noodles instant mussels mussels and paste the potential developed into alternative food Indonesian society.
- Food processing technology at the household level is a technology that is traditional, technology to processing mussels are still many that are manual, only a few are using mechanical equipment. The relatively small scale of production has not been encouraging employers to use modern technology, although the technology is easily obtained both from government and private institutions.
- The test results using the dryer cabinet is equipped with artificial intelligence-based dryer systems with expert system showed that as expected (according to the required standards). This is due to the engine can be mimicked by a lady who was an expert in food paste made from drying aspect.
- Balonggabus village of Candi Sidoarjo District is a regional producer of mussels and the potential to continue to develop products using a variety of mussels to the processed form of dryer machine (cabinet dryer) based on expert system so that the resulting product would be great texture, aroma and taste. Various processed mussels that can be developed such as instant kupang paste, Kupang flour, Kupang crackers, noodles mussels, mussels etc so that products become more durable.

#### REFERENCES

- Astawan, M. 2005. Membuat Mi dan Bihun. Penebar Swadaya, Jakarta.
- Brown, A.H., W.B. Arsdell dan E. Lowl. 1964. Drying Methods and Drier. Di dalam W.B. Arsdell dan M.J. Copley (eds). Food Dehydration. The AVI Publ. Co. Inc., Westport, Connecticut.
- Desrosier, NW. 1988. Teknologi Pengawetan Pangan. Penerjemah M. Muljoharjo. Penerbit UI Press. Jakarta. 614 hlm.
- Durkin, John. 1994. Expert Systems Design and Development, Prentice Hall
- Hou, G. dan M. Kruk. 1998. Asian Noodle Technology. [http://secure.aibonline.org /catalog/example/V20Iss12.pdf](http://secure.aibonline.org/catalog/example/V20Iss12.pdf). [28 Juni 2006].
- Koswara, S. 1992. Teknologi Pengolahan Kedelai. Pustaka Sinar Harapan, Jakarta.
- Kumalaningsih, S., Suprayogi, dan B. Yuda. 2005. Teknologi Pangan. Membuat makanan siap saji. Trubus Agrisarana 2005. Surabaya
- Merdiantyanti A. 2008. Paket Teknologi Pembuatan Mi Kering dengan Memanfaatkan Bahan Baku Tepung Jagung. Skripsi. Jurusan Ilmu dan Teknologi Pangan. IPB
- Paisey RYA. 2011. Kajian Pengeringan Ubi Jalar Tumbuk Instan (Mashed Sweet Potato) Menggunakan Alat Pengering Tipe Fluidized Bed Dan Oven Cabinet. Jurusan Teknologi Pertanian Fakultas Pertanian Dan Teknologi Pertanian Universitas Negeri Papua Manokwari

[10]. Sarastani D, Mie kering berbahan baku ubi jalar (formulasi, proses produksi, karakteristik produk). Supervisor Jaminan Mutu Pangan - Program Diploma – IPB  
 [11]. Pramudono, Bambang Ir, 1988, “Humidifikasi dan Pengeringan”, UGM, Yogyakarta  
 [12]. Wirakartakusuma, K. Abdullah, dan A. Syarif. 1992. Sifat-sifat Pangan. Departemen Pendidikan dan Kebudayaan. Direktorat Jendral Pendidikan Tinggi. Pusat Antar Universitas pangan dan Gizi. Institut Pertanian Bogor. Bogor  
 [13]. Yulianingsih E. 2007. Proses produksi biskuit Di PT. Tiga Pilar Sejahtera Food Tbk Unit Ivstragen Jawa Tengah. Program

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 [14]. Ignizio, James, 1991, Introduction to expert system: Development of Rule Based Expert System, University of Houston, MCGraw-Hill, pp.199.  
 [15]. Awad, E.M., 1996. Building expert systems: principles, procedures, and applications. West publishing company.  
 [16]. Cetinkunt, Sabri, 2007, Mechatronics, John Wiley & Sons, Inc, ISBN 9780471479871.

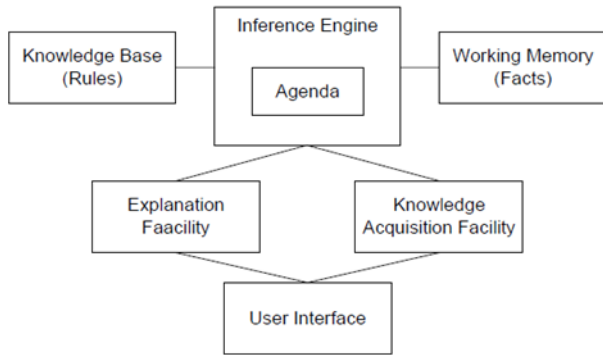


Figure 1. Expert System structure

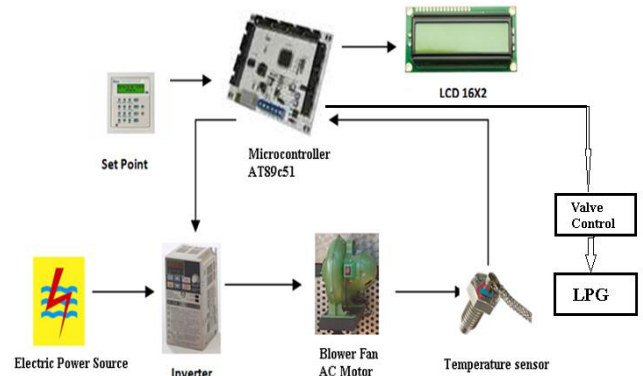


Figure 4. Diagram of the dryer working system

A transfer of knowledge from experts to Machines

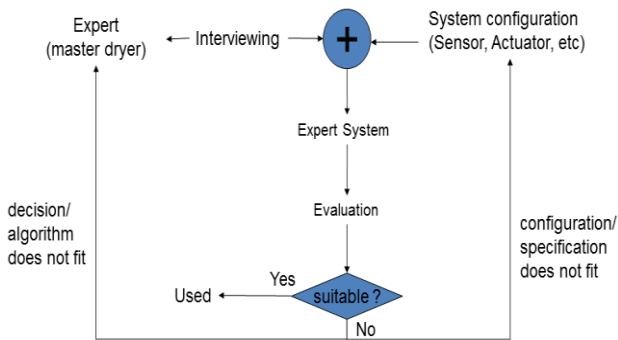


Figure 2. A transfer of knowledge from experts to machine

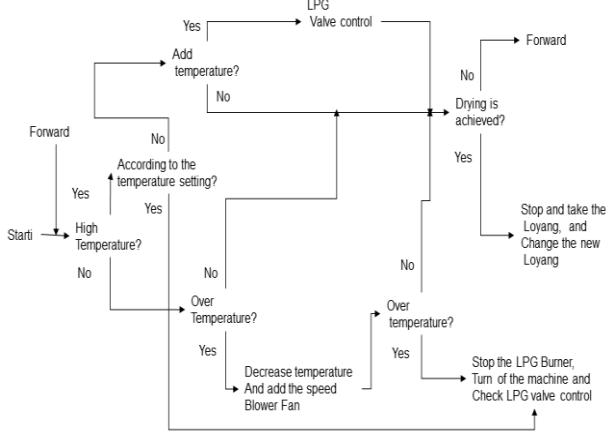


Figure 3. Decision Diagram Expert System



(a) Front view



(b) Side view

Figure 5. Types of Fluidized Bed Dryers

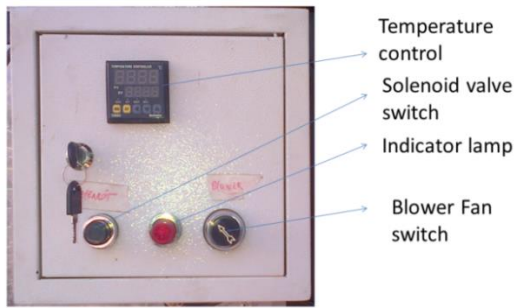


Figure 6. Control panel of Fluidized Bed Dryers



Figure 6. Earth Leakage Circuit Breaker (ELCB)

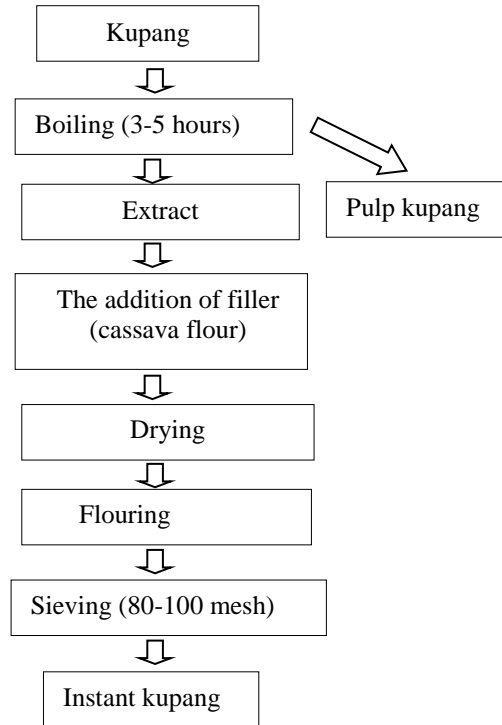


Figure 7. The drying process of making flour paste instant kupang

TABLE 1.  
TESTING RESULTS OF THE DRYER MACHINERY

Stage	Temperature (°C)	Duration (minutes)	Amount of material ( kg )
1	205	5	
2	205	5	10 kg
3	210	6	
4	205	5	