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Application of Smart Oven Technology as an Effort to Increase Smoked Egg Production and Quality in Sania MSME

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Abstract. Mitra Home salted egg industry SANIA MSME is an MSME that engages in duck cultivation and the production of Smoked Salted Eggs. SANIA MSME was founded by a duck breeder group in 2008 in Kawedusan Ponggok Village, Blitar. Smoked salted eggs are known for their burnt/smoky aroma and greasy egg yolks. Smoked egg production is done manually using the use of smoking drums. These manual devices are only capable of baking 150 grains per day. Meanwhile, damage due to smoking with an oven drum can reach up to 15-20%. This can reduce profits by up to 20% per cycle of the smoking process. Damage occurs when users forget or are too late to lower the drum oven's temperature before it reaches temperatures of 1000C or more. The uneven heat can also result in a reduction to taste and greasiness of the egg yolks. Manual ovens take 7-10 hours at 80-900C to cook. From discussions with partners, it was discovered that they needed egg smoking ovens that feature thermoregulators and can produce even flows of smoke automatically. There is a need for technological innovation in the egg fumigation equipment category in the form of smart egg smoking ovens complete with thermoregulators and automatic smoke airflow systems. Smart ovens have the potential to increase productivity by 75% with a faster smoking process of 3-4 hours. The service method was carried out by way of producing a design for smart ovens, socialization and assistance in the use of the device, assistance in the production of smoked eggs, and program evaluation. The results of the mentoring activity suggested that the production of smoked eggs can increase by 70% with the level of cooking damage sitting at less than 10% and an improvement in the product's taste.

Keywords: Smoked salted eggs, thermoregulator, smoke airflow, oven, greasy

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INTRODUCTION

Currently, the COVID-19 pandemic has hit the world, including Indonesia, with its effects reverberating across various sectors, one of which is the reduction of economic growth in almost all parts of Indonesia. Although the economic shock caused by the pandemic has gradually subsided as the domestic financial market stabilized and several economic sectors have sprung up, given its effect on both the supply and demand sides of the economy, recovery efforts still require more time (Modjo, 2020). The spread of the virus has also shown no signs of slowing down as the trend for confirmed cases and deaths continues to increase. Because of this, the government has imposed an emergency Community Activity Restriction (PPKM). The negative effects of PPKM implementation are significant on the local economy which will encourage a decrease in gross domestic product (GDP) growth in 2021 by 0.5%-1% of the baseline projection, resulting in a significant economic slowdown.

The economic slowdown has also affected the livestock sector, one of which is the "Sania MSME" industry. Sania MSME was established through the initiative of a duck breeder group in 2008. The business location is in Sumanding Hamlet, RT 03 RW 06, Kawedusan Ponggok Village, Blitar. The business began with as little as 100 ducks and a production capacity of 60-70 eggs but has now expanded to produce 8000 eggs/week. The selling price of good quality duck eggs is between Rp. 1,500 – Rp. 1.700 / item or Rp. 30,000 – Rp. 40,000/kg. Since 2014, duck egg farming has become a popular trend. Many new competing duck breeder entrepreneurs had sprung up, resulting in a decrease in the selling power of duck eggs by up to 30%.

Figure 1. Community activity on the making of smoked salted eggs

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Salted egg is a product that is savored by the general population. The production of salted egg is through the process of ionization of NaCl salt which then diffuses into the egg through the pores of the outer shell. The production of salted egg is not only for food preservation but also to improve their taste. The most common method of production is through a traditional method, namely by soaking eggs in salt solutions and wrapping them in clay mud mixed with red brick powder or by directly rubbing burnt ash onto them. salt penetration by diffusion in traditional salting methods takes place slowly. Speeding up the process at which the salt penetrates the egg can be done by increasing the level of NaCl in the soaking solution. In addition to this, to speed up salt penetration, the egg salting process can also make use of the pressure method. The pressure method is a way to improve the quality of salted eggs and is also meant to speed up the process of making them. The pressure method is applied by increasing the osmotic pressure difference between the pressure outside and the pressure inside the egg. The higher the osmotic pressure difference, the higher the rate of diffusion of NaCl into the egg.

Salted eggs consumed by the general population have a variety of flavours and very high levels of yellow grit. These variations range from less salty to very salty and oily. This is due to differences in the concentration of salt used during the salting process. Eggs Salted with clay mud, which is a mixture of clay and salt at a ratio of 1:1, will be able to last for 30 days.

To extend the shelf life of salted eggs ever further, Sania MSME tried to innovate by producing smoked salted eggs. Smoking is a viable way of extending the shelf life of salted eggs by combining heat with chemicals such as formaldehyde and phenol which functions to inhibit the growth of bacteria (Simajuntak, 2013). Additionally, because smoked salted eggs contain less water content, longer shelf life is guaranteed. However, the process of smoking, practiced at Sania MSME is still a traditional method, namely by baking or smoking eggs in a drum/barrel. these drums/barrels have a capacity of 150 grains. The smoking process takes about 7-10 hours with a temperature between 80-90 0C. The materials used to produce the smoke are coir/coconut shells. The method has shortcomings such as temperature/heat settings and smoke flow that are not optimal. Workers must reduce the fire's intensity and remove the eggs if the temperature becomes too hot so as to not damage them. This greatly hampers the production of smoked salted eggs, both in terms of quantity and quality, and reduces the smoky/greasy taste. Smoking eggs only takes about 8 hours

using a smokehouse with a maximum temperature of 80°C. The resulting product's shelf life can go up to 37 days without affecting its protein contents. The lack of a temperature control system in the partner's smokehouse results in uncontrollable smoking and heating rates. The existing combustion chamber is an open combustion system. Exposure to oxygen keeps the fire burning and produces little smoke. The purpose of this service program is to increase the productivity of Sania MSME by replacing manual smoking drums with smoke ovens which will help improve time efficiency, increase production quantity and quality, and preserve the resulting product's taste.

PROBLEM

Along with the increasing popularity of smoked salted eggs produced by Sania MSME, the demand for smoked eggs increases every year. In 2017 the demand has reached ± 8000 grains/month. The production capacity is only capable of smoking/baking 150 grains daily. Per month, the maximum production capacity is only at 4500-5000 grains. Meanwhile, the damage caused by smoking with an oven drum can reach up to 15-20%. This can reduce profits by up to 20% per production cycle. Damage occurs when users forget or are too late to lower the drum oven's temperature before it reaches temperatures of 100ºC or more. The uneven heat can also result in a reduction in the taste and greasiness of the egg yolks. Partners needed egg smoking ovens that feature thermoregulators and can produce even flows of smoke automatically.

METHOD OF IMPLEMENTATION

The method used in this community service program is a combination of several methods, namely producing a design for smart ovens, socialization and assistance in the use of the device, assistance in the production of smoked eggs, and program evaluation, because in its implementation, before the equipment was given to partners, the program's implementation team provided training in advance on how to operate the devices to make sure the activities would run smoothly.

The stage began with the device designing phase, which considered surveys and discussions with partners on the problems associated with manual smoke drums. The results of this survey inspired a smoke oven design equipped with a thermoregulator and an automatic smoke airflow system. After completion of the design, the process continues by

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2774-6348 online

characterizing the detailed performance of each supporting item. Next was the real-life application of smart smoke ovens in the field.

The next stage was to socialize the use of smart smoke ovens using a demonstration plot, where instructions on the functionality of the device are explained to partners, namely: fuel preparation and how to ignite the smoke source in the fire oven. Dried coconut fibers/shells (moisture content at 10-15%) were used as a source of fuel to obtain a strong smoky taste. The next step was to put salted eggs into the smoke oven, open the smoke channel into the smoke oven, and adjust the temperature in the smoke oven as needed. Usually, the temperature needs to sit around 80-90ºC. If the temperature relayed on the thermoregulator's screen reaches the desired number, turn off the heat in the fire oven. The smoking process occurs in the oven tube. The resulting smoke will flow and distribute evenly throughout the oven. This process lasts for 2-3 hours. When finished, the eggs are removed from the smoke oven and are ready to be packaged once they have cooled.

The next stage is production assistance. Production assistance was done to determine egg quality including the taste and damage percentage. In the mentoring method, mentoring was carried out on the use of smoke ovens, which is associated with productivity, the percentage of egg damage, and the taste including the egg's greasiness.

The next stage is an evaluation of the results of smoked salted egg production through the use of smart smoke ovens by paying attention to the level of doneness, taste, and the percentage of egg damage. Questionnaires were given to partners regarding the production of smoked salted eggs using smart ovens. The image below is a summary of the results of the questionnaire:

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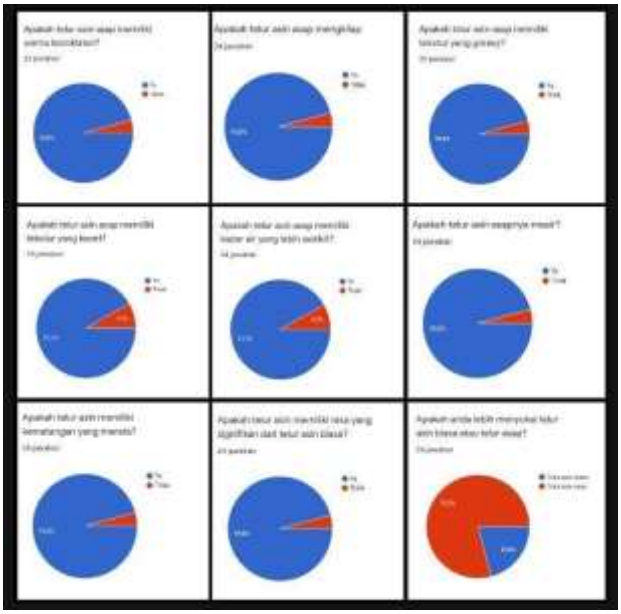

Figure 2. Smoked Salted Egg Presentation

It can be concluded that most of our partners prefer making smoked salted eggs by using smart ovens as evidenced by the data which stated that smoked salted eggs are brown, shiny, have greasy textures, are gritty, and evenly cooked at 95.8%. Smoked salted eggs made using the oven have mat textures, and less moisture content at around 91.7% and those who prefer smoked salted eggs to ordinary salted eggs are 79.2% amongst the 24 partners who filled out the questionnaires.

RESULT AND DISCUSSION

The results of the production assistance program can be seen in Table 1.

Table 1. Results of program assistance

Before Program	After Program
• Production still uses traditional oven drums	• Production using smart smoke ovens equipped with thermoregulators and automatic smoke airflow systems • Partners are given operational guidance on the use of smart ovens to facilitate ease of use and troubleshooting
• Smoke drums are only capable of baking 150 salted eggs	• Smart smoke ovens are capable of smoking and baking 300 salted eggs/smoking cycle
• Smoke drums take 7-8 hours to smoke and bake salted eggs	• Smart smoke ovens only take 3-4 hours to smoke and bake salted eggs
• Damage to the eggs from the use of smoking drums can reach up to 15-20%	• Damage to the eggs from the use of smart smoke ovens are less than 10%

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2774-6348 online

The use of smart smoke ovens with thermoregulators and smoke airflow systems can increase the productivity of Sania SMSE. Admittedly, Modifications to the design which increases effectiveness and efficiency had already been carried out by Afridonal (2014). However, the tool only emphasizes the heat generated from the weight of coconut coir as fuel. Coconut coir weighing 23 kg produces energy of 82,685 kcal/100 smoked salted eggs. Meanwhile, research by Al-Baarri (2016) stated that an increase in temperature above 100ºC can increase damage. Based on these literatures, modifications were made to the smart smoke oven, namely automation of the thermoregulator and the addition of a smoke airflow system to even out smoke formation. The description of the tool can be seen in Figure 3.

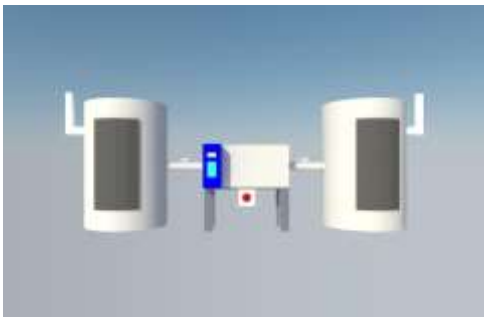

Figure 3. Smart Oven Design

A. Model Design of Smart Salted Egg Smoker Oven and Its Operational Principles

The smart smoke oven has each of the following parts: **Smoke Tubes**. consisting of two tubes. The tubes are the main component of this machine which functions as a chamber for smoking salted eggs. The tubes are made of stainless steel to provide even cooking of salted eggs. Stainless steel is a type of metal that is highly resistant to corrosion. The corrosion resistance of stainless steel is due to an invisible layer that develops due to the oxidation of stainless steel with oxygen which forms a protective anti-corrosion layer (Supriyanto, 2012). **Automatic Temperature Regulator**. This temperature regulator is equipped with a thermometer that functions as a heat regulator with a minimum temperature of 70ºC and a maximum temperature of 90ºC. **Manual Heat Regulator**. This tool serves to regulate temperature when using one of the smoke tubes for the production process. **Chimney**. The chimney serves to release smoke when the temperature reaches the maximum. **Stove**. The stove functions as a burner to produce smoke. The **Combustion Tube** serves as a fuel container for smoke generation. The burner mat serves to hold coconut coir when the burning process takes place. **Ash Partition** serves to collect ash produced during the combustion process. This eases the ash removal process. The **Egg Smoker Mat** functions to

hold eggs and accommodate for larger-scale productions and organize the eggs. The combustion tube can be seen in Figure 4.

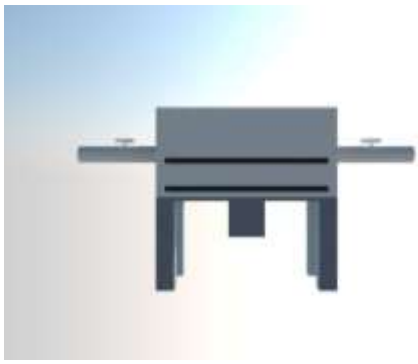

Figure 4. Smart Oven Design

Following the design process, the component design process is carried out based on the load variable and other factors to ensure the device's durability and can be used properly and safely. By this stage, it was found that adjusting the temperature to 80°C was difficult because air played a factor in the rise and fall of the stove's temperature in the Smart Oven, thus, determining wind direction is important to obtain the desired temperature.

B. Operational and Maintenance Instructions

The process of working on the smart oven machine goes as follows; namely, salted eggs that enter the tube will go through a smoking or drying process and the temperature in the oven will be maintained while the machine is working. When the temperature in the tube has reached the maximum set limit, the fan will turn off automatically until the temperature drops. And when the tube temperature reaches its lowest limit, the fan will turn on again. After approximately 2-3 hours of the smoking process, the salted egg can be directly removed from the smoke tube and cooled manually.

C. Tools and Materials preparation

LPG is fuel for kitchen utensils which are commonly used for gas stoves. LPG is an acronym for Liquefied Petroleum Gas. Aside from being a fuel source for kitchen utensils, LPG is also quite widely used as fuel for motor vehicles such as modified motorcycles. The main function of the **Regulator Hose** is to reduce pressure as the gas flows from the gas cylinder into the stove. **Ring lock** is one of the hand tools commonly used in car workshops. Usually used to disassemble parts of a car's components, both for checking and repairing. This ring lock has a hexagonal jaw shape. The goal is to make it easier to use in hidden and

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narrow spaces. **Salted Egg** is a general term for egg-based dishes that are preserved by salting (the addition of excess salt to deactivate the breaking down of enzymes). Most salted eggs are duck eggs, although the process works for other eggs too. Coconut shell is the solid waste of processed coconuts that had their meat extracted to produce coconut milk. **Coconut shells** are generally used to make fuel, for household purposes, or to make souvenirs.

D. Materials used

The main ingredient is salted egg. Salted egg is a general term for egg-based dishes that are preserved through salting (the addition of excess salt to deactivate the breaking down of enzymes). Most salted eggs are duck eggs, although the process works for other types of eggs too.

E. Combustion Process

The combustion process is a sequence of chemical reactions between a fuel and an oxidant, accompanied by the release of heat which is sometimes accompanied by light in the form of a glow or fire. The combustion process aims to produce smoke from coconut shells that had been burnt. This combustion process is carried out at the desired temperature.

F. Smoking Process

Smoking is a method of cooking, flavouring, or preserving food. The food is smoked with heat and smoke is produced from the coconut shell. This smoking process is carried out for 2-3 hours at a temperature of 70°-80°C.

G. Checking Process

The checking process aims to check or sort salted eggs that have been evenly cooked, if there are still defects in the salted eggs, they can be smoked again.

H. Smoke Oven Characterisation

To ensure the smoke cabinet worked according to plan, characterization needed to be carried out first. All parts, including controllers, egg racks, and the combustion chamber were given performance tests. The test results show that all parts of the smoke oven work according to their respective functions. A single egg was tested by cooking for 3-4 hours with optimal temperatures between 70°-80°C and 5 minutes of stove pre-heating to produce color, texture, and taste similar to the examples provided by partners.

Figure 5. Smart Ovens Poste-Testing

I. Field Implementation

Characterization results conclude that the prototype (smart oven) and the peripherals are ready to be implemented to the home industrial (*mitra*). The independent experiment was to include 60 salted eggs (machine maximum capacity about 300 eggs) which were ready to be smoked. The eggs are smoked for 2 hours with gradually observation, to make sure it's on optimal temperature and expect to produce the finest smoked eggs. The total time of smoking with post processing were taking about 3-4 hours.

J. Implementation Results in Sania MSME Partnership

The implementation was carried out 5 times during the mentoring process using a total of 250 eggs, which can be seen in Table 2.

Table 2. Program assistance at Sania MSME

Indicator	Result (Average)
Temperature	78.9 ℃
Source of smoke	Coconut coir and shell
Time	2.95 Hours
Damage to eggs (per egg)	23 pcs
Damage to eggs (%)	< 10

Results from the Table 2 show that the smart smoke oven can be used in Sania MSME because the damage percentage was less than 10% and the smoking duration was also the fastest at 2.95 hours. This will reduce production time per smoking cycle resulting in a higher yield per day.

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CONCLUSION

Smart smoke ovens with thermoregulators and automatic smoke airflow systems can increase the production yield of smoked salted eggs in Sania MSME by 70%. For one egg smoking cycle, the oven tube can accommodate 300 eggs. The smoking process takes about 3 hours with a temperature of 800 C and the damage rate is less than 10%.

ACKNOWLEDGEMENT

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Original Title:
Pemanfaatan Teknologi Oven Cerdas sebagai Upaya Peningkatan Produksi dan Kualitas Telur Asap di UMKM Sania

Abstrak. UMKM Mitra Home industri telur asin SANIA adalah UMKM yang bergerak dalam bidang budidaya bebek dan produksi Telur Asin Asap. UKM Sania didirikan atas inisiatif kelompok peternak bebek pada tahun 2008 di Desa Kawedusan Ponggok Blitar. Telur asin asap mempunyai taste aroma bakar/asap dan *greasy* (berminyak) pada kuning telurnya. Produksi telur asap dilakukan secara manual dengan menggunakan tong pengasapan. Dengan alat drum manual ini dalam satu hari hanya mampu mengoven 150 butir. Sedangkan kerusakan yang terjadi akibat pengasapan dengan oven drum mencapai 15-20%. Hal ini dapat mengurangi keuntungan sampai 20% per satu siklus proses produksi pengasapan. Kerusakan terjadi jika pekerja lupa atau terlambat untuk menurunkan suhu di dalam oven drum sehingga suhu meningkat mencapai 100^0C bahkan lebih. Belum lagi panas yang tidak merata mengakibatkan *taste* asap dan *greasy* pada kuning telur berkurang. Oven manual membutuhkan waktu selama 7-10 jam dengan suhu 80-90^0C. Berdasarkan diskusi dengan mitra diketahui mitra membutuhkan oven pengasap telur yang mempunyai *thermoregulator* dan aliran asap yang merata yang bisa bekerja secara otomatis. Perlu inovasi teknologi alat pengasapan telur berupa oven cerdas pengasap telur dengan *thermoregulator* dan *smoke airflow* otomatis. Oven cerdas dirancang akan meningkatkan produktivitas sebesar 75% dengan waktu pengasapan lebih cepat 3-4 jam. Metode pengabdian yang dilakukan adalah perancangan pembuatan alat oven cerdas, Sosialisasi penggunaan alat, pendampingan penggunaan alat dan pendampingan produksi telur asap dan evaluasi program. Hasil kegiatan pendampingan adalah produksi telur asap meningkat 70 % dengan kerusakan telur kurang dari 10% serta kualitas rasa dan *taste* telur yang lebih bagus.

Kata kunci: Telur asin asap*, thermoregulator, smoke airflow*, oven, *greasy*