An Internship Report
On
"Manufacturing of Fortified Rice
in
Masafi Agro Foods Industries Ltd."

Supervised by

Mrs. Effat Ara Jahan
Lecturer (Senior Scale)
Department of Nutrition and Food Engineering
Daffodil International University

Submitted by:

Koushik Mittra
ID: 163-34-574
Department of Nutrition & Food Engineering
Daffodil International University

Date of Submission: 19th June, 2021

Letter of Transmittal

Date: 19th June, 2021

Dr. Sheikh Mahatabuddin
Head
Department of Nutrition & Food Engineering
Daffodil International University.

Subject: Submission of Internship report.

Dear Sir,

This is my great pleasure to submit the Internship report on "Manufacturing of Fortified Rice in Masafi Agro Foods Industries Ltd." as partial fulfillment of the BSc. in Nutrition & Food Engineering (NFE) program.

This report is prepared based on the observed knowledge and operations performed in Masafi Agro Foods Industries Ltd. and by studying relevant data as well. Sincere efforts have made to make the report valuable. The overall internship program will be very helpful for my future career.

I therefore would like to place this report to you for your important suggestion and consideration.

Yours Faithfully,

Koushik Mittra

ID: 163-34-574
Department of Nutrition and Food Engineering
Daffodil International University

Certificate of Approval

I am pleased to certify that the internship report on “Manufacturing of Fortified Rice in Masafi Agro Foods Industries Ltd.” conducted by Koushik Mittra, bearing ID: 163-34-574 of the department of Nutrition and Food Engineering has been approved for presentation and defense/viva-voce.

I am pleased to hereby certify that the data and findings represented in the report are the authentic work carried out by Koushik Mittra. I strongly recommend the report presented by Koushik Mittra for further academic recommendations and defense/viva-voce. Koushik Mittra bears a strong moral character and a very pleasant personality. It has indeed a great pleasure working with him. I wish him all success in life.

Dr. Sheikh Mahatabuddin

Head
Department of Nutrition & Food Engineering
Daffodil International University.

Effat

Mrs. Effat Ara Jahan

Lecturer (Senior Scale)
Department of Nutrition and Food Engineering,
Daffodil International University

Acknowledgement

At the beginning I would like to express my gratitude to my internship supervisor **Mrs. Effat Ara Jahan**, Lecturer (Senior Scale), Department of Nutrition and Food Engineering, Daffodil International University for her continuous support, monitoring and suggestions throughout this internship period. Her cordial effort was so much helpful to finish the program.

My cordial gratitude goes to **Dr. Sheikh Mahatabuddin**, Head, Dept. of Nutrition and Food Engineering, for his support and accepting this Degree as well.

My Deep gratitude and sincere thanks to **Professor Dr. Ahmed Ismail Mustafa**, Dean, Faculty of Allied Health Sciences, and to **Professor Dr. Md. Bellal Hossain**, Associate Dean, Faculty of Allied Health Sciences, Daffodil International University for their cooperation and valuable advice.

I would also like to express my gratitude to **Mohammad Ali Chowdhury**, Chairman & Managing Director, Masafi Group for allowing me in his organization to carry out the internship program. I am grateful the authority and all the stuffs and coordinators of **Masafi Agro Foods Industries Ltd.** For their continuous cooperation suggestion throughout the entire program.

Lastly, I would like to show my gratitude to The Almighty for giving me enough strength and security to fulfil the program successfully.

Executive Summary

Masafi Agro Foods Industries Ltd. is one of the subsidiaries of Masafi Group's Food Division. The company was established by Masafi group in 2015. The main purpose of the company is to reduce micronutrient deficiency of the vulnerable groups by providing them with fortified rice in a fair price. Many people of the country have already been benefited from this project. The company have collaborated with World Food Program and also have been working with The Government of Bangladesh. The main purpose of the internship program was to observe the production process of fortified rice with the modern technologies and also to gather practical knowledge as well. In this report, the main represented topics are company profile, overview of rice fortification technology and production process of fortified rice with brief discussion about the machineries involved in the production of fortified rice. The overall experience gained from the internship program will definitely strengthen my career.

Table of Contents

Chapter No.	Title		Page Number
	Letter of Transmittal		II
	Certificate of Approval		III
	Acknowledgement		IV
	Executive Summary		V
1	**Introduction of the Study**	1.1 Origin of the Report	2
		1.2 Objective of the Program	
		1.3 Source of Information	3
		1.4 Limitation of the report	
2	**Organization Profile**	2.1 Overview of Masafi Agro Foods Industries Ltd.	5
		2.2 Products of the Company	6
3	**Overview of Rice Fortification**	3.1 Rice Fortification	8
		3.2 Importance of Rice Fortification	
		3.3 Methods of Rice Fortification	
		3.4 WHO Recommendation	9
4	**Production of Fortified Rice**	4.1 Production of Fortified Rice with Hot Extrusion Technology	11
		4.2 Target levels of Micronutrients in Fortified Kernel	
		4.3 Process Flow Chart of the production of Fortified Rice with Hot Extrusion	12
		4.4 Summarization of the Main Processing Steps	13-15
		4.5 Main Machineries of Rice Fortification plant	16-20
5	**Conclusion**		22
	Reference		23

Chapter One:

Introduction of the Study

1.1 Origin of the Report

As a requirement of Bachelor Degree in Nutrition and Food Engineering at Daffodil International University, I was allowed to accomplish my Internship at Masafi Agro Foods Industries Ltd. The company produces Fortified Rice and Fortified Kernel in order to reduce malnutrition among the people whose staple food is rice and who don't take or can't take proper amount of micronutrient from their diet. Among the different sections of the industry, I got chance to work at the production section. The report was prepared by analyzing and studying related data and records during the industrial involvement. Best effort has made to make the report as informative as possible by observing and collecting all the important data related to processing of fortified rice.

1.2 Objective of the study

1.2.1 General Objective

The main objective of the study was to learn about the production process of Fortified Rice and the related machineries of the production line.

1.2.2 Specific Objective

- To gather practical knowledge along with the related theoretical knowledge.
- To get idea about the rice fortification and to keep a role in reducing micronutrient deficiency in the country.
- To understand about the industrial working environment.
- To learn the ways of interaction with the stuffs, workers and employees of the industry.
- To be beneficial in the job sector.
- To learn about the modern machineries and technologies related to rice fortification.

1.3 Source of Information

1.3.1 Primary Source:

Primarily Data are collected by:

- Observing and visiting the production area.
- Performing practical work.
- By focusing unit operation involved with the processing.
- By taking formal and informal interview of the employees and stuffs of the industry.

1.3.2 Secondary Source:

Data were also collected from:

- Official website of Masafi Group
- Several journals and articles
- Published survey reports
- Manual and files of the organization

1.4 Limitation of the report

- Due to the rules and regulation of the company some confidential information could not be collected.
- Due to the time restriction of the program some information could not be collected.
- Due to busy working schedules officials were not able to guide us all the time.
- Due to the pandemic situation created by the COVID-19 sufficient data could not be collected.

Chapter 2:

Organization Profile

2.1 Overview of Masafi Agro Foods Industries Ltd:

Masafi Group started their trading business in 1968. Since then, they have established many Manufacturing Units and mills. Masafi Agro Foods Industries Ltd. is one of the three industries of Masafi Food division. Masafi group has started this industry at 2015.

Along with the snacks like biscuit, bread Masafi wanted to start the production of Fortified Rice to reach the Bangladeshi mass market. That's why they have started Masafi Agro Foods Industries Ltd. They believe that adding this staple super food to their portfolio is a key milestone in their fight against micronutrient malnutrition.

Masafi Agro foods industries Ltd. produces high nutritive Fortified Rice named "Vita Rice". This Fortified rice is fulfilled with the important micronutrients that are required for a healthy diet. This staple super food is designed to make in such a way that it can alone can meet most of the nutritional requirement for a person daily. This initiative is helping to reduce malnutrition in school going children and other vulnerable groups like old women, adult girls etc.

Masafi Agro foods industries Ltd. has been working with World Food Program (WFP) and the Government of Bangladesh with this new product with the target of reducing micronutrient deficiency of the country.

Figure 1: Logo of Masafi Agro Foods Industries Ltd.

2.2: Products of the company:

Product Name	Production Capacity (MT Per Month)
Fortified Rice Kernel	25
Fortified Rice	7425

Chapter 3:

Overview of Rice Fortification

3.1 Rice Fortification:

Fortification of rice is a process where traditional rice is mixed with micronutrients like vitamins and minerals. So, the nutritional quality of the rice will improve and the consumers will be benefited without any health risk.

3.2 Importance of Rice Fortification:

Fulfilling the daily requirement of micronutrient is tough for those people whose main food is rice. Because traditional polished rice contains mainly starch as the nutritious bran of the rice grain is removed during the milling process. People of some Asian countries consume about 70% calorie form rice [1]. That's one of the reasons behind the micronutrient deficiency among the people of the many South Asian countries. Hidden hunger makes a person vulnerable to so many diseases. So, the micronutrients like iron, zinc, vitamins etc. can be incorporated in the regular diet of large number of people by providing them with the fortified rice. As the fortified rice doesn't have noticeable sensory difference with the comparison with traditional polished rice, it will be well received by common people if it is economically accessible [2]. So, Fortified rice is potentially an excellent product to alleviate micronutrient deficiency of the people of these countries.

3.3 Methods of Rice Fortification:

There are three main technologies available for the production of fortified rice. They are: coating, extrusion and dusting.

- ***Coating method***: In this process micronutrient mix is mixed with waxes and gums and then sprayed on the surface of rice grains in several layers. Then it is blended with traditional polished rice at about a ratio of 1:100.

- ***Dusting method:*** In this method powdered form of micronutrients is blended with bulk rice. This method is carried out with the electrostatic forces between the rice's surface and the micronutrients.

- ***Extrusion method***: Here milled rice is powdered and mixed with a micronutrient premix containing vitamins and minerals. Fortified rice kernels (FRK) are produced from this mixture with the help of extruder machine. FRK is then added to traditional rice in ratio ranging from 1:50 to 1: 200. Finally Fortified Rice is produced which is nearly identical to traditional rice in texture, aroma, and taste.

  Extrusion process is divided as Hot extrusion (70-110ºC) and Cold extrusion (70ºC). Warm extrusion which is a combination of hot and cold extrusion process is also used by some of the manufacturers.

3.3 WHO Recommendation [3]

- Where rice is a staple food, fortification of rice with iron is recommended as a public health strategy to improve the iron status of the population.

- Fortification of rice with vitamin A can be used as a public health strategy for reducing Vitamin A deficiency and improving the iron status of the people as well.
- Fortification of rice with folic acid may also be used as a public health strategy for improving the folate nutritional status of populations

Chapter 4:

Production of Fortified Rice

Masafi Agro Foods Industries LTD. follows hot extrusion technology for the production of their Fortified Rice.

4.1 Production of Fortified Rice with hot extrusion technology

Production process of fortified rice can be divided into two stages:

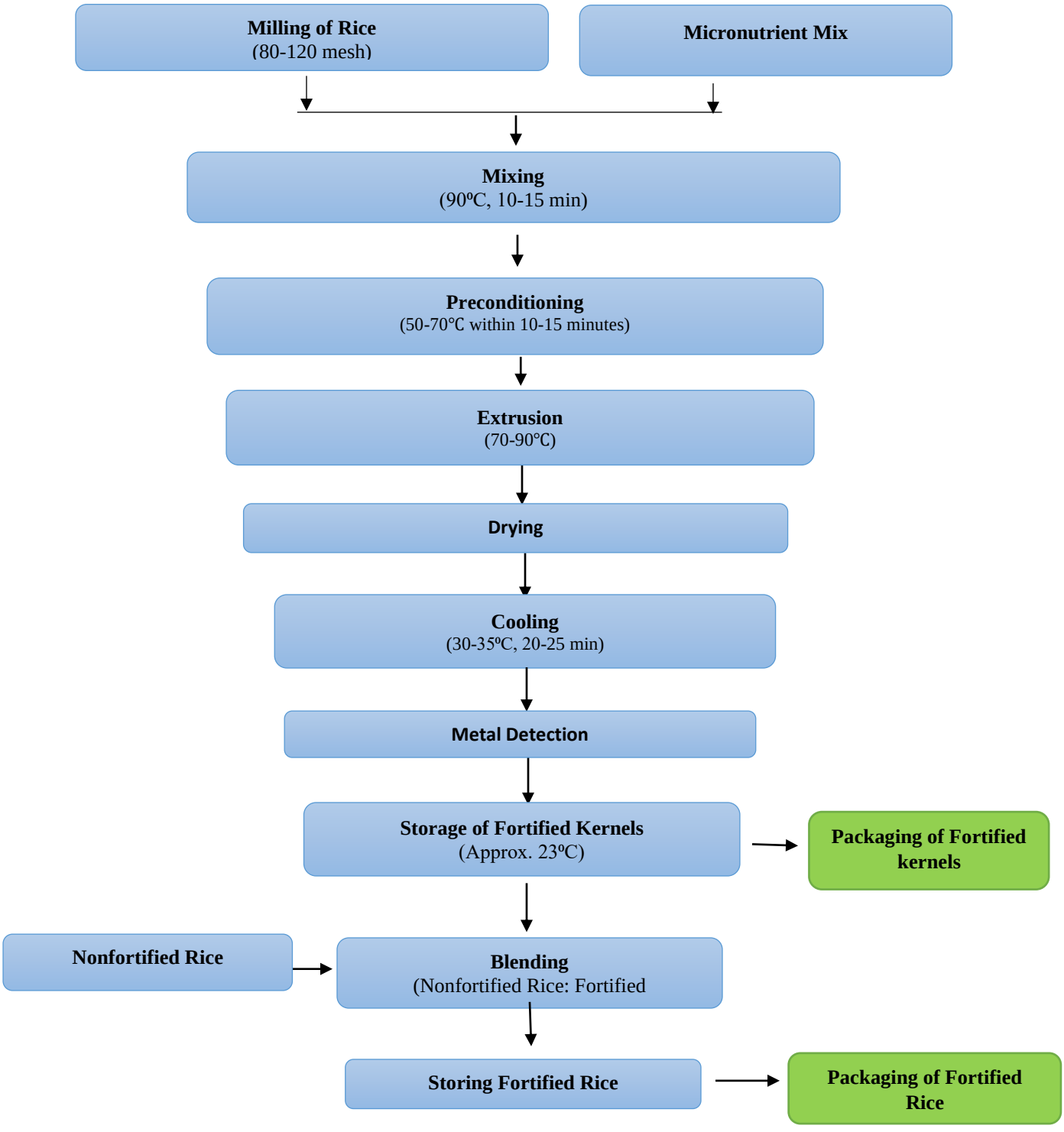
1. **Production of Fortified Kernel (FK):** The rice shaped grains called Fortified rice kernel (FRK) or Fortified Kernel (FK) are produced using powdered rice, Micronutrient Premix (Vitamin A, Vitamin B1, Vitamin B12, Folic Acid, Iron and Zinc) and water passing the dough through an extrusion machine.

2. **Blending of FK and Rice:** FK are mixed with the traditional milled rice in 1:100 ratio. The blended product is called Fortified Rice (FR) which includes the adequate amounts of nutrients.

4.2 Target levels of Micronutrients in Fortified Kernel [4]

Micronutrient	**Analytical Target /gram of FK**
Vitamin A	500 IU
Vitamin B1	0.5 mg
Vitamin B3	7.0 mg
Vitamin B6	0.60 mg
Folic Acid	0.13 mg
Vitamin B12	1 mcg
Iron	4.0 mg

4.3 Process Flow Chart of the production of Fortified Rice with Hot Extrusion:



Flow Chart 1: Production of Fortified Rice

4.4 Main processing steps of the production of Fortified Rice with Hot Extrusion:

4.4.1 Milling of Rice

A homogeneous powder of rice (80-120 mesh) is made first. Finely grinded homogenous powder helps to increase production capacity. To make powdered rice, traditional polished rice is fed with a pneumatic transport to the mill. The speed of the conveyor determines that which amount of rice grains will be conveyed into the grinding chamber.

4.4.2 Mixing

Mixing of raw materials is usually done by a mixer. The mixing chamber is filled in several batches and the powdered rice and micronutrient premix (made with the combination of Vitamin A, Vitamin B1, Vitamin B12, Folic Acid, Iron and Zinc.) are added. Mixing is carried out with the addition of hot water (~90°C) until the ingredients are homogeneously distributed (at least for 10-15 minutes) for facilitating the pre-cooking of the ingredients in the preconditioner. Conveyors transfer the prepared mixture into the hopper and then to the extruder.

4.4.3 Preconditioning

Preconditioning is essential for providing uniform moisture penetration into the mixture of rice powder and micronutrient mix. It is done by placing the prepared mixture into the steam so that the extruder can convert it into a dough with minimal energy input. Generally preconditioning process lasts 10-15 minutes and the obtained temperature ranges between 50 and 70℃.

4.4.4 Extrusion Process

During extrusion, preconditioned mixture of raw materials is compressed into a dough, and then finally shaped into rice shaped products called Fortified Kernels (FKs). This technology is based usually on a screw system which compresses the dough within a barrel, heats it, and then pushes it through small openings called die holes. Strands of dough are cut into individual kernels (L: 4-6mm; W: 1.2-2mm) by rotating knives. Starch gelatinization and protein denaturation are occurred for the high temperature which is produced during extrusion process (70-90℃). FKs produced in this way are then transferred for drying.

4.4.5 Drying and Cooling

Extruded Kernels are conveyed to dryer for drying to make the product shelf stable. As extruded kernel is a highly dense product, drying is conducted very carefully to prevent the forming of condensation and to avoid cracking. Drying at an ambient temperature as gently as possible is used for preventing blunt surface of kernels. After drying, the kernels are cooled at 30-35ºC for 20-25 minutes.

4.4.6 Metal Detection

Before storing, Fortified kernels are conveyed through a metal detector which usually detects Iron (3.2mm), Non-Ferrous (4.5mm), and Stainless Steel (5.0 mm). Detected metals are removed by the magnet of the detector.

4.4.7 Storage and Packaging of FK

FKs are stored and packaged by keeping away from direct sunlight and in a well-ventilated area at room temperature (approximately 23°C). Storage time in tanks is minimized and FKs are packed in as soon as possible. Because stability of micronutrients is sensitive to direct light, moisture or prolonged storage.
Most of the FKs are used to produce Fortified Rice and the remaining amount is stored for distribution.

4.4.8 Blending

Produced Fortified kernels are blended with regular rice with the ratio of 1:100 by the help of a blender. A doser is attached with the blender for measuring the Fortified Kernels in the exact ratio. The doser is calibrated as per as the required ratio for both of the FKs and nonfortified rice for ensuring the uniformity of the mixing.

4.4.9 Storing and Packaging of Fortified Rice

After blending, fortified rice is stored and quickly packaged in bags as per the standard operating procedure. Usage of appropriate packaging materials with the proper sealing techniques are the first priority. Keeping moisture content of the fortified rice under 14% is recommended for avoiding microbiological growth[5].

Figure 2: A) Blending of raw materials during the production of Fortified Rice;
B) Produced Fortified Rice in Masafi Agro Foods Industries Ltd.

Figure 3: Close view of Fortified Rice

4.5 Main Machineries of Rice Fortification plant

4.5.1 Mill

Milling of rice is done by millers. Diskmill is used in the manual operations while a Hammer mill is used most of the time for the automatic operations. Hammer mills shows optimum results for continuous cost-effective production. The granulation of the flour can be determined by the sieve of a hammer mill.

Figure 4: Hammer mill

4.5.2 Doser

A doser or feeder is used to feed the mixture of raw materials into the extrusion process and also feed the FKs and rice into the blender. There are two types off dosing system: volumetric and gravimetric. A doser consists of a premix hopper and a dosing screw. The screw continuously feeds the flour from the hopper into the extruder. In the gravimetric dosing system, the hopper is able to measure the weight of the loading material and also able to calculate the output of the feeder. Very accurate continuous feeding rate is assumed by the usage of gravimetric doser. Volumetric dosres are used mainly in the manual lines.

Figure 5: Gravimetric dosing units

4.5.3 Preconditioner

A preconditioner is a machine which mixes the rice powder and micronutrient mix homogeneously with the help of steam. Steam is applied to moisten the mixture of raw materials and to gelatinize the starch of rice particles as well. A preconditioner is able to incorporate 30 to 35% water into the mixture. Steam rate, time duration etc. are must be set before starting the process.

Figure 6: Double Screw preconditioner

4.5.4 Extruder:

Extruder compresses the preconditioned mixture into a dough by heating and mixing operation and finally cuts it like rice grain. An extruder is mainly a combination of following components: barrel, screw, die plate and cutter. These components are briefly described below:

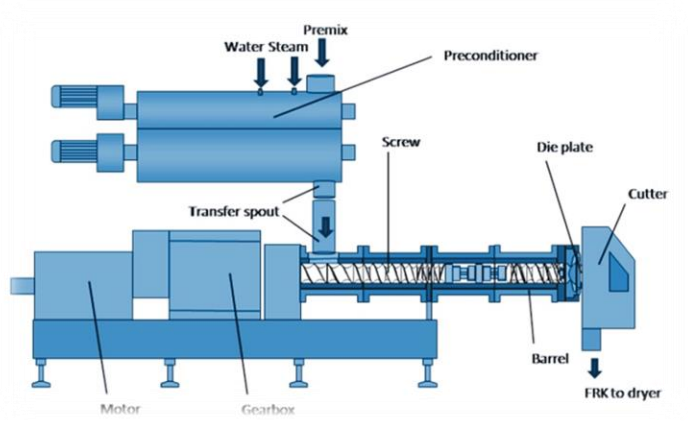


Figure 7 (A): Schematic overview of an extruder with its typical components ;(B): Twin screw extruder

Barrel

It's a cylindrical machine where external temperature control system is connected. Screw is located inside of the barrel and the die plate is set in the front of the barrel. It basically heats the mixture and helps screw to mix and compress the dough.

Figure 8: A Barrel with electrical heat Source

Screw

Arrangement of the individual screw elements is the most important part of the hot extrusion process. This powdery state of the mixture is converted into a homogeneous dough with the help of screw. Screw is located inside of the barrel of an extruder and behind the die plate. Twin screw and single screw systems are available.

Figure 9: A Screw of extruder

Die plate

Die plate contains several rice shaped holes, situated at the end of the screw. Position of screw and die holes is responsible for the shape of Fortified Kernels. The width and length of the holes also affect the final shape of Fortified Kernels. The dough in the extruder is homogeneously distributed over the entire die plate and forced to exit through the holes.

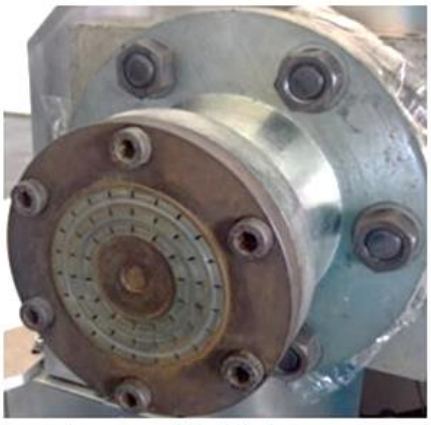


Figure 10: Die Plate of an Extruder

Cutter

The dough exits the extruder through the die holes as a continuous strand. This strand is cut with rotating knives and rice shaped Fortified Kernels are obtained. The speed of the blades, the distance of the blades from the die plate etc. can be adjusted during the process. A controlled cutting process gives the best FK.

Figure 11: Cutting process with cutter

4.5.5 Dryer and cooler

Drying process is done by a dryer with a high air throughput. Due to the high airflow, sticking of kernels can be avoided and a large amount of water can be removed in a very little time. Fluid bed dryer along with the belt dryer is used in most of the plants. Cooling with appropriate cooler is done with ambient temperature to avoid cracking.

Figure 12: Fluid bed dryer

4.5.6 Blender

Blender is needed to mix the FRK with the traditional rice. Generally, 2 types blender is used:

1. Batch blender: It's a medium capacity blending system (up to 500 kg/h) which is used in the small capacity rice mills. This blending system consist of a mixing drum with paddle arrangement, dozer, bucket elevator and conveyor. It blends the mixture with several small batches. Example: Forberg blender
2. Continuous blender: It's basically used in the large production plant. The blender is basically a combination of traditional rice grader with the vibratory doser.

Figure 13: A) Forberg blender: A batch blender with paddle arrangement; B) Inside view of a Forberg blender

Chapter 5:
Conclusion

Conclusion:

The micronutrients deficiency is one of the major problems in the developing countries like Bangladesh. Rice fortification is the important potential tool to decrease the effects of hidden hunger. Fortification of rice is still a neglected subject. But the initial has already been taken by the companies like Masafi Agro Foods Industries Ltd. In the internship program the production process of Fortified rice was observed. Operation techniques of some of the machineries that involved in the production lineup of the Fortified rice are also learnt. Along with this, it was a great opportunity to know about the overall industrial environment. The overall experience will definitely be helpful to me for my future career. I would like to thank the Department of Nutrition and Food Engineering and Masafi Agro Foods Industries Ltd. for proving me such opportunity.

Reference:

(1) FAOSTAT. 2009. Food Consumption Tables.; Food and Agriculture Organization of the United Nations (FAO).

(2) Hossain, B.; Jahan, E.; Kamrul, N. Rice Fortification Scale Up to Remove Malnutrition with Cost Effective Technology of Bangladesh Rice Fortification Scale Up to Remove Malnutrition with Cost Effective Technology of Bangladesh. *Food Nutr. Curr. Res.* **2019**, *2* (1), 99–105.

(3) Organization, W. H. Guideline: Fortification of Rice with Vitamins and Minerals as a Public Health Strategy. **2018**, *2006* (7), 9–11. https://doi.org/10.1301/002966402320285218.GUIDELINE.

(4) USAID. FORTIFIED MILLED RICE FOR USE IN INTERNATIONAL FOOD ASSISTANCE PROGRAMS, 2016.

(5) World Food Programme. Technical Specifications for the Manufacture of: FORTIFIED RICE, 2010.