LOGIC
Journal of Engineering Design and Technology
Vol. 22 No. 2 July 2022; p. 176 - 180

p-ISSN : 1412-114X
e-ISSN : 2580-5649
http://ojs2.pnb.ac.id/index.php/LOGIC

REDESIGN OF HORIZONTAL COFFEE ROASTERS WITH TEMPERATURE, TIME AND ROTATION CONTROLS

Suherman I Ketut[1)], Suirya I Wayan[2)], Anom Adiaksa I Made[3)]

1) Mechanical Enginering Departement, Bali State Polytechnic, Mangupura, Bali, Indonesia
2) Mechanical Enginering Departement, Bali State Polytechnic, Mangupura, Bali, Indonesia
3) Mechanical Enginering Departement, Bali State Polytechnic, Mangupura, Bali, Indonesia

Correponding email [1)] : ketutsuherman@pnb.ac.id

Abstract. Coffee roasting is still using clay pans with the traditional method and heat is obtained from firewood fires. Only 20% of the national coffee bean production which reaches 600,000 tons per year is processed and marketed as secondary products. The physical mechanical properties of coffee at a faster decrease in water content, increase in brittleness and accelerated color change are affected by temperature and roasting time
The stirrer rotation speed control on the prototype horizontal roaster was added while still emphasizing the traditional method. The roaster is equipped with a temperature and time control to add product creations. The temperature of 120^0 C has not shown the level of maturity where the weight has not been reduced properly and there is no aroma. A temperature of 180^0 C for 15 minutes with a rotation of 100 RPM causes a significant weight loss of 60% and a strong coffee aroma has been smelled. The temperature was set to 220^0 C despite varying times and rotations, resulting in a completely burnt and immature coffee exhibited by a weight loss of only 50%. The results showed that temperature, time and rotation greatly affect the quality of roasting results.

Keywords: roaster, coffee, temperature, rotation.

1. INTRODUCTION

Only 20% of the national coffee bean production of 600,000 tons per year can be processed and marketed in the form of secondary products, including roasted coffee, ground coffee, ready-to-eat coffee, and several other types of secondary coffee [1]. The role of the roasting process is very important in the final result of coffee (brewed coffee). The roasting process needs to be considered, including the roasting machine system, tube plate material, the stability of the ignition source, and the type of coffee raw material and its characteristics, other important aspects of roasting are temperature, time, skill, and roasting technique [2-5]. The coffee is roasted using a 25 cm and 16 cm diameter Teflon pan. The treatment studied was a temperature of around 180 to 250 C with a baking time of 12 minutes. The results showed that the roasting process using conduction heat with a closed roaster causes the heat to spread evenly so that the roasting process runs faster. Temperature treatment and roasting time have an effect on changes in the physical mechanical properties of coffee, namely a faster decrease in water content, an increase in brittleness and an acceleration of dark color change [6-8]. The study stated that the quality of roasting coffee beans is determined in terms of method, temperature and time, but the tools used still have large dimensions and are relatively expensive.

Automatic roasters and grinders are made with a microcontroller system [9-12]. A gas-fueled microcontroller roaster using a microcontroller as an electrical controller is made with only 3 settings for the coffee profile, namely light 12.8 minutes, medium 17 minutes and dark 25 minutes with a temperature setting of 245 degrees Celsius [13-15]. A microcontroller-based automatic system is implemented so that the desired profile quality can be determined.

Previous research has obtained a maximum roasting result of 30 minutes and an international standard coffee profile [16-18]. The weakness of the tool in the construction of the lid. The construction of the vertical

model has problems when opening or closing causing delays for pouring or picking up coffee beans. This construction has an impact on the preheating time lag so that it affects the shape of the pot that resembles a tube causing the coffee parts to not mix well. In this study, the lid will be redesigned and change the shape of the pot into a semicircle to reduce the time lag that occurs and the turbulence of stirring the coffee beans. The quality of the results is obtained by adding a stirrer rotation regulator

.

2. METHODS

2.1. Design

The lid and roasting pan were redesigned to optimize the roasting process. The effect of temperature, time and rotation on the roasting results is seen from the test results. Temperature, time and rotation are fixed variables, while the independent variable is coffee weight.

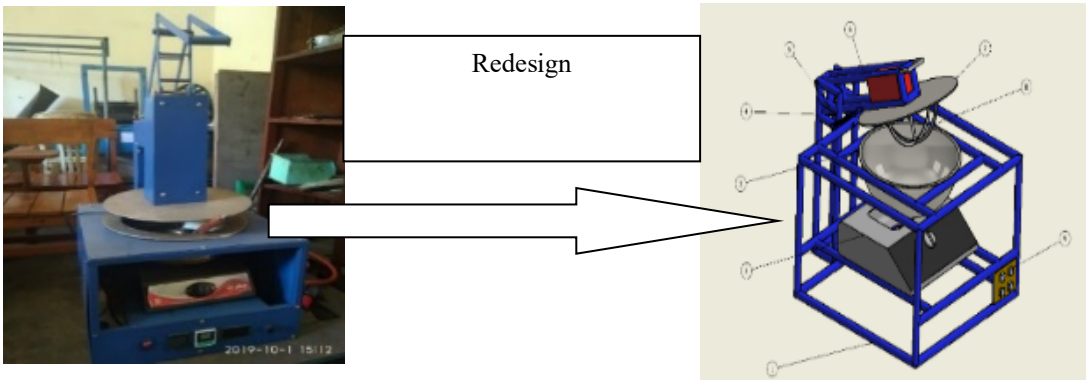


Figure 1. Redesign roaster tool

2.2. Research instrument

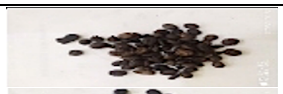
Coffee samples were taken from Pupuan because later the tool will be applied in the area. Pupuan sub-district is ranked first with production most robusta coffee for three consecutive years. According to data from the Bali Province Central Statistics Agency (2017), it shows that Pupuan District always ranks first for the highest Robusta coffee production in Tabanan Regency from 2014 to 2016. With a total of production in 2014 was 3,732.87 tons, in 2015 it reached 5,196.53 tons, and 5,170.99 tons in 2016. Judging from the large number of coffee plantations in Pupuan District, so that the community can take advantage of this potential by processing coffee beans into ground coffee (Dyah, 2019). Roasted profiles were recorded from weight and aroma based on temperature variables 120^0 C – 220^0 C, time 15 - 30 minutes and rotation 100 - 150 RPM.

3. RESULTS AND DISCUSSION

3.1. Result of Data

The Robusta coffee productivity in Pupuan District is evenly distributed in all villages in Pupuan District. Distribution of Robusta coffee productivity by area or region is found in each village [19]. Soil characteristics were: dark curved soil color, deep solum depth (>100 cm), high CEC, high base saturation, and good soil fertility. According to the Soil Taxonomy system, the soil family is Typic Hapludands, ash, isohyperthermic. Land suitability is quite suitable for coffee and salak [20][21]. The test was carried out with samples of Robusta coffee from Pupuan Tabanan. Testing by varying the temperature, time and stirrer rotation. Observations were made visually from color and aroma. The test results can be seen in Table 1.

Table 1. The test result

Temp	RPM	Time (min)	Coffe (scent)	Visual	Water Content (%)	
					Before	After
120	100	15	Weak		12.0	8.0
		30	Burnt		5.0	3.0
	150	15	Weak		6.0	4.0
		30	Become strong		4.0	4.0
160	100	15	Become strong		4.0	3.0
		30	Become strong		4.0	2.0
	150	15	Become strong		7.0	5.0
		30	Become strong		6.0	4.0
180	100	15	Strong		4.0	3.0
		30	Strong		5.0	2.0
	150	15	Strong		5.0	3.0
		30	Strong		4.0	3.0
220	100	15	Become strong		4.0	2.0
		30	Burnt		4.0	2.0
	150	15	Become strong		4.0	2.0

3.2. Descriptive Analysis

The roasting process in the coffee processing process affects the characteristics of the coffee. Variations in temperature give the characteristics of the physical properties of the roast. The temperature of 120 C has not shown the level of maturity with the aroma yet to be smelled and the weight loss is not too good. A temperature of 180^0 C for 15 minutes with a rotation of 100 RPM shows a good level of maturity where the coffee aroma is strong and there is a significant weight loss of 60%. The temperature was set to 220^0 C despite varying the time and spin, resulting in a completely burnt and immature coffee, a weight loss of only 50%. Temperature, time and rotation greatly affect the quality of roasting results.

4. CONCLUSION

The redesign of the lid and pan as well as the addition of temperature, time and roasting rotation controls affect the characteristics of the roasted coffee.

5. ACKNOWLEDGEMENT

Thank you to The Bali State Polytechnic Research and Community Service Center, for providing full support to the implementation of this research.

6. REFERENCES

[1] Acharaporn Duangjai, Kanittaporn Trisat, Surasak Saokaew, 2021, *Effect of Roasting Degree, Extraction Time, and Temperature of Coffee Beans on Anti-Hyperglycaemic and Anti-Hyperlipidaemic Activities Using Ultrasound-Assisted Extraction*, Food Sci. 2021;26(3):338-345

[2] Huluager Endeshaw, Abera Belay, 2020, *Optimization Of The Roasting Conditions To Lower Acrylamide Content And Improve The Nutrient Composition And Antioxidant Properties Of Coffea Arabica*, PLOS ONE, Department of Food Science and Applied Nutrition, Addis Ababa Science and Technology University Addis Ababa Ethiopia

[3] Achmad Ir. Zainun, 2006, *Machine Element I,* PT. Refika Aditama Sularso, Bandung.

[4] Suherman I Ketut, Suwirya I Wayan, Surya Dewi Ni Wayan Merda, 2020, *Horizontal Coffee Roaster Design with Temperature and Time Control*, Logic: Jurnal Rancang Bangun dan Teknologi, volume 20, nomor 1, hal. 40-45 Politeknik Negeri Bali.

[5] Alfarizqi Abdillah Mita, 2017, *Design of Microcontroller-Based Automatic Coffee Roasters and Coffee Grinders,* Design and Manufacturing Engineering Study Program Department of Ship Engineering State Marine Polytechnic Engineering, Surabaya.

[6] Ayu Purnamayanti Ni Putu, 2017, *Effect of Temperature and Roasting Time on Physical Characteristics and Sensory Quality of Arabica Coffee (Coffea arabica L),* Journal of Beta Volume 5 Number 2, Agricultural Engineering Study Program Faculty of Agricultural Technology, Udayana University.

[7] Božana Odžaković, Natalija Džinić , Marija Jokanović , Slavica Grujić, 2019, *The Influence Of Roasting Temperature On The Physical Properties Of Arabica And Robusta Coffee*, Apteff, 50, 1-352, University Of Banja Luka, Faculty Of Technology, Stepe Stepanovića 73, 78000 Banja Luka, Republic Of Srpska, Bosnia And Herzegovina.

[8] Dadang D Hidayat, Ashri Indriati, Cecep E Andriansyah, Ari Rahayuningtyas, Arie Sudaryanto, 2020, *Changes Of Some Engineering Properties Of Coffee Beans Due To Roasting Process*, Asian Journal Of Applied Sciences, Volume 08 – Issue 01, Research Center For Appropriate Technology, Indonesian Institute Of Sciences, Subang

[9] Agung Putra Agastya, 2017, *Microcontroller Based Portable Coffee Bean Roasting Machine,* Department of Electrical Engineering Faculty of Science and Technology Sanata Dharma, Yogjakarta University.

[10] Dyah Orchid Wulandari Sang Ayu, Widyantara I Wayan, Agung I Dewa Gede, 2019, *Profil Usaha Pengolahan Kopi Bali Tugu Sari Pajahan Di Desa Pajahan, Kecamatan Pupuan, Kabupaten Tabanan*, Jurnal Agribisnis Dan Agrowisata Issn: 3685-3809, Vol. 8 Nomor 4, 479-485, Udayana University.

[11] Satrijo Saloko, Yeni Sulastri, 2019, *The effects of temperature and roasting time on the quality of ground Robusta coffee (Coffea rabusta) using Gene Café roaster*, AIP Conference Proceedings 2199 060001.

[12] Henrietta, Christyana Purnomo, Eko Hari, 2020, *Analisis Pengaruh Suhu Penyangraian Kopi Terhadap Karakteristik Beberapa Jenis Kopi*, Scientific Repository, IPB-Bogor.
[13] Hery Sonawan, 2010, *Machine Element Design,* Alfabeta, Bandung.
[14] Hirt Dr.Ing.M, 1986, *Machine Element,* Second Edition Publisher Erlangga, Jakarta.
[15] Juerg Baggenstoss, Luigi Poisson, 2008, *Coffee Roasting and Aroma Formation: Application of Different Time-Temperature Conditions*, Journal of Agricultural and Food Chemistry 56 (1) 5836-46, American Chemical Society.
[16] Khoirul Ajmi Siregar, 2017, *Modification of Rotary Type Mechanical Coffee Roaster,* Food Engineering and Pert Volume5 Nomor 2, Agricultural Engineering Study Program Faculty of Agriculture, Sumatera Utara University.
[17] Kiyukatsu Suga, 1987, *Basic Planning and Selection of Machine Elements,* PT. Pradnya Paramita, Jakarta
[18] R.S.Kurmi J.K.Gufta, 1980, *Text Book Of Machine Design Euraisa Publishing House* (Pvt) LTD, Ram Nagar, New Delhi.
[18] Masagus Imran Maulana, 2016, *Analysis of Roasted Coffee Maturity Using Thermographic Image Processing in Order to Automatically Control Roasted Coffee Quality,* Department of Mechanical Engineering Faculty of Engineering, Lampung University
[19] Alit Aridana I Komang, Astra Wesnawa I Gede, 2018, *Iklim Mikro Dan Produktivitas Perkebunan Kopi Robusta (Cafea Robusta) Di Kecamatan Pupuan*, Jurnal Pendidikan Geografi Undiksha, Volume 6 Number 3, 145-153, Ganesha University.
[20] Febrin Sidabutar, I Gusti Putu Ratna Adi, I Made Mega, 2021, *Evaluasi Kesesuaian Lahan Tanaman Pangan dan Perkebunan di Desa Belimbing, Kecamatan Pupuan, Kabupaten Tabanan*, Nandur, Volume 1 Nomor 1, 35-45, Udayana University.
[21] Sutyadnyani Ida Ayu, Mega I Made, 2012, *Karakteristik Tanah Andisol Pada Lahan Kering Di Desa Batungsel, Kecamatan Pupuan, Kabupaten Tabanan Untuk Budidaya Kopi Dan Salak*, Agrotrop Jurnal Ilmu Pertanian, Volume 1 Nomor 1, 1021-1026, Udayana University.