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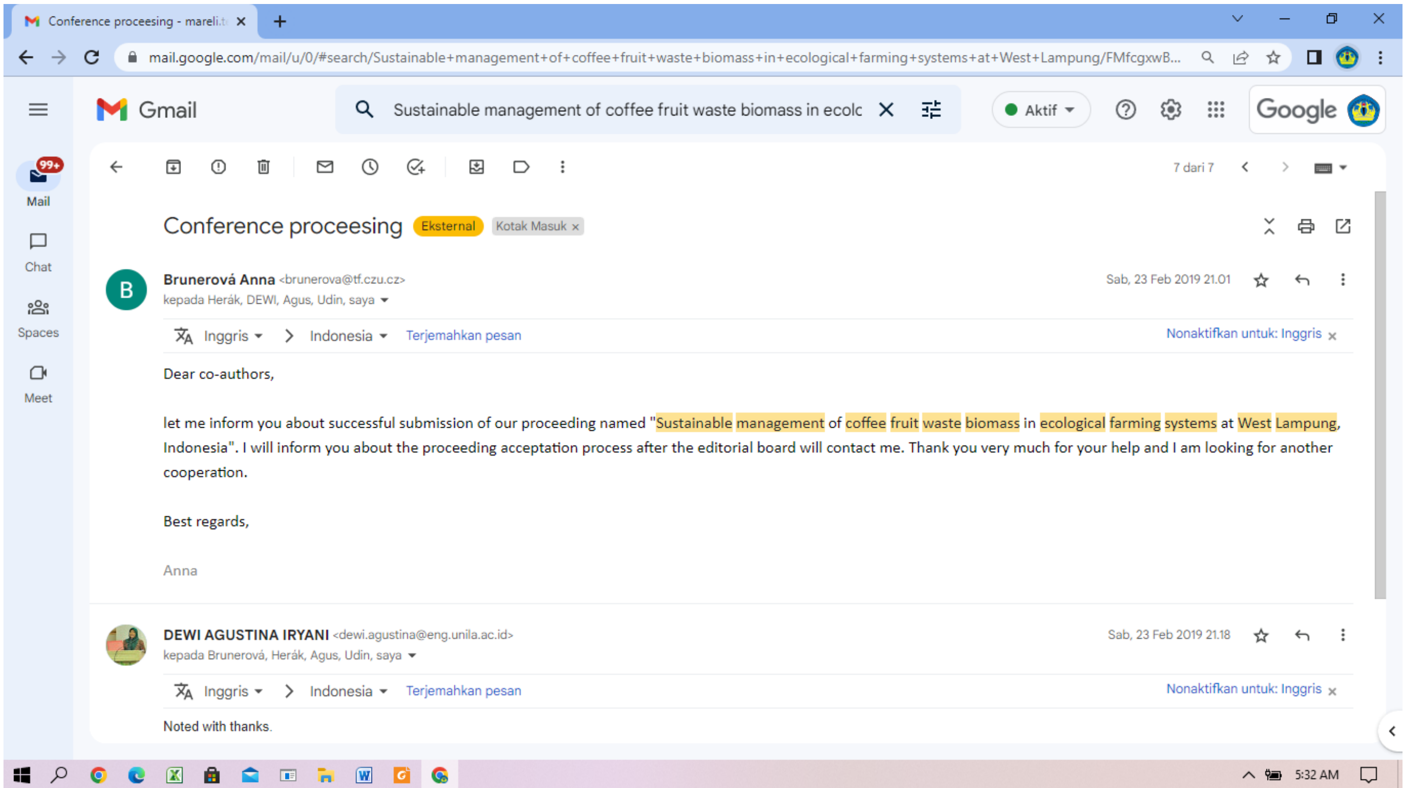

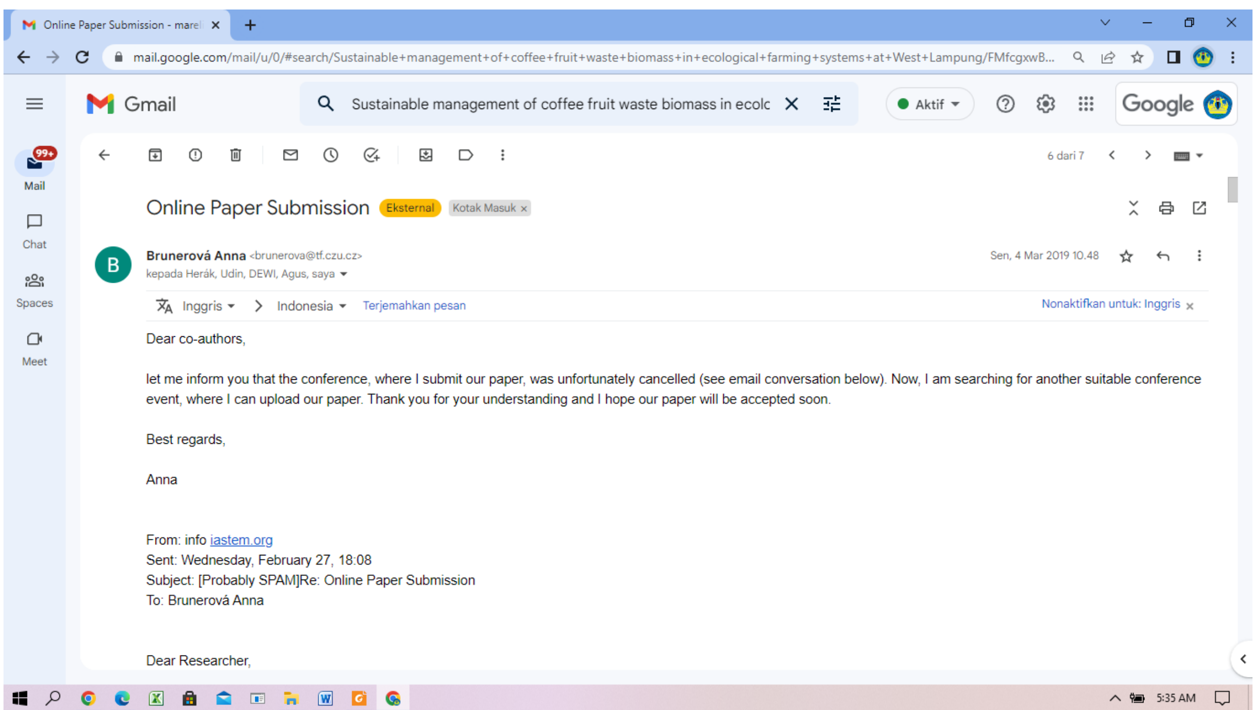

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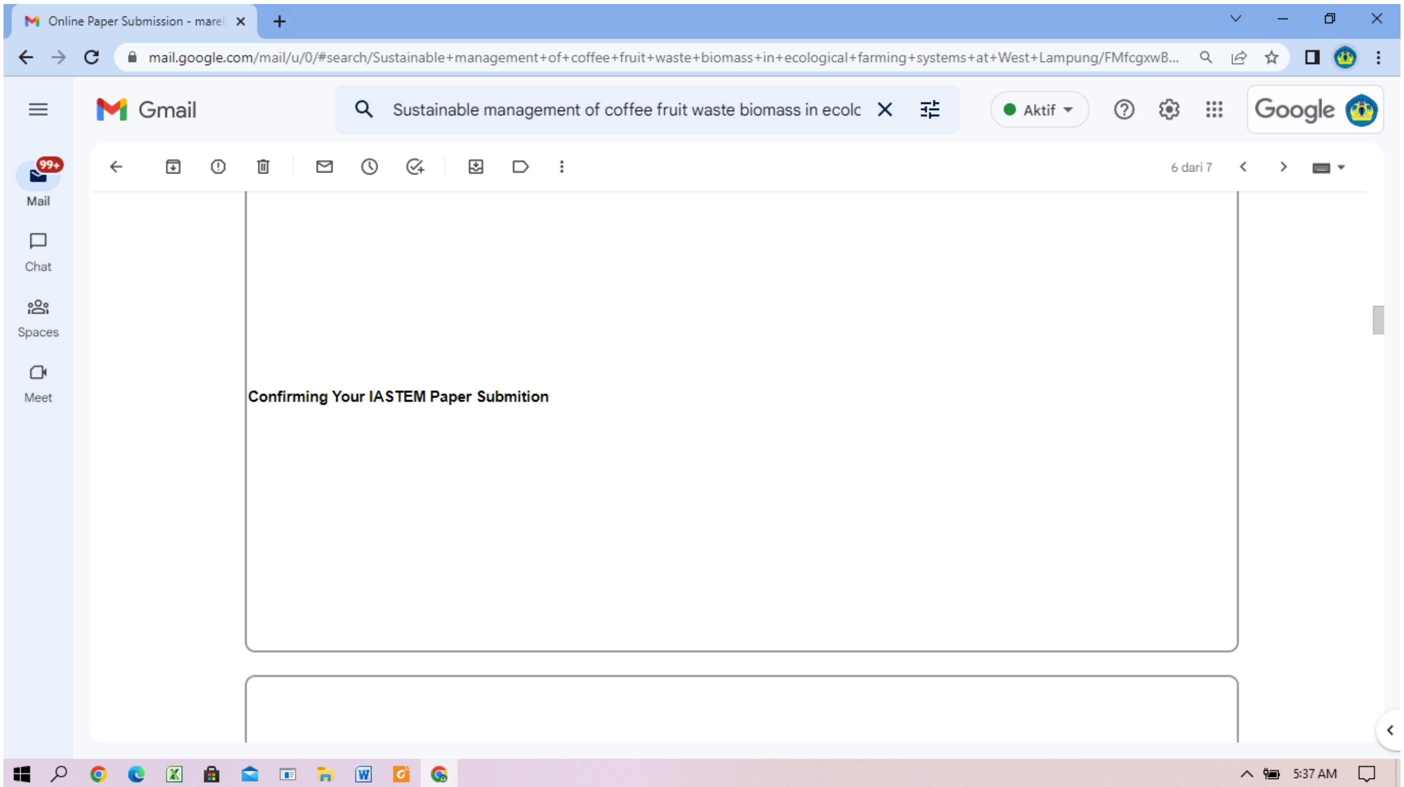
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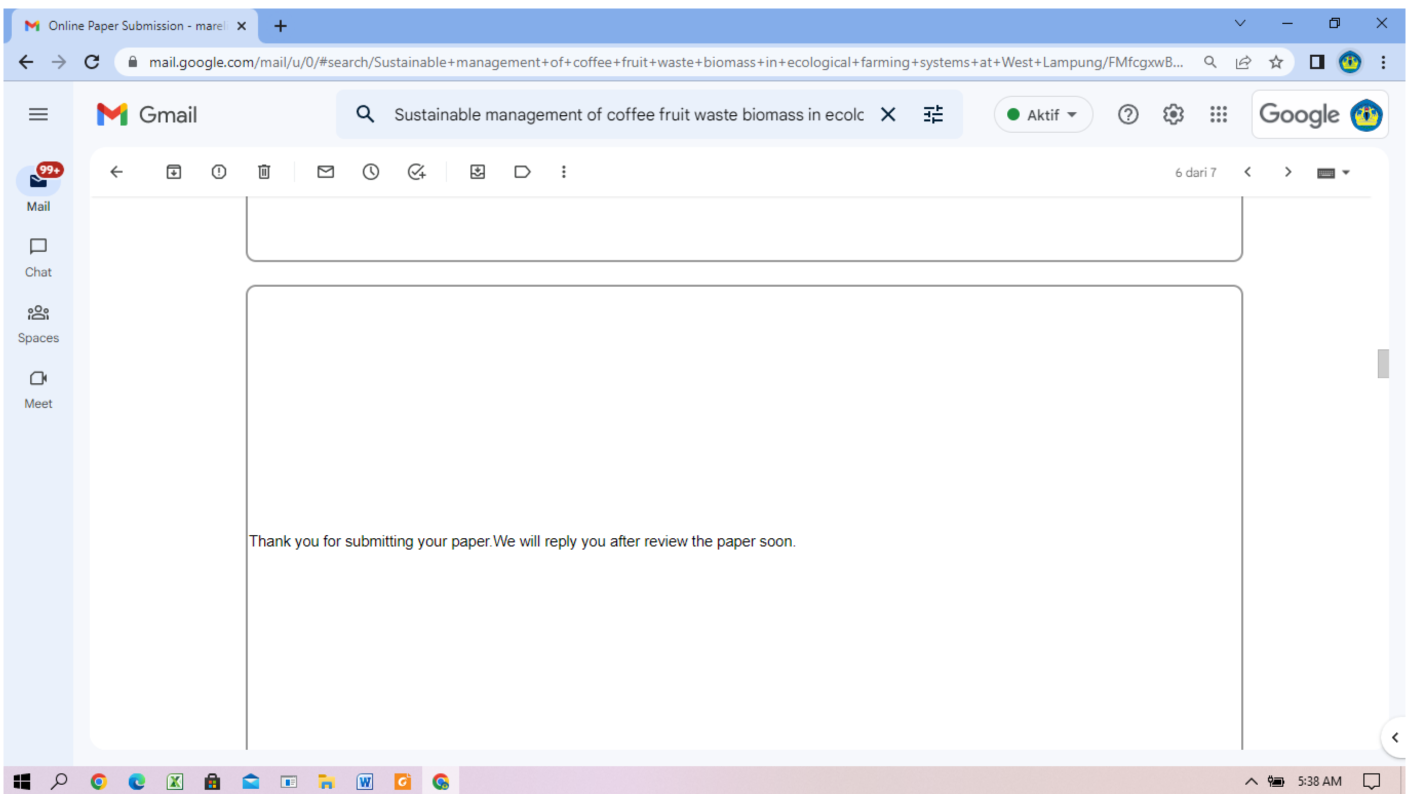
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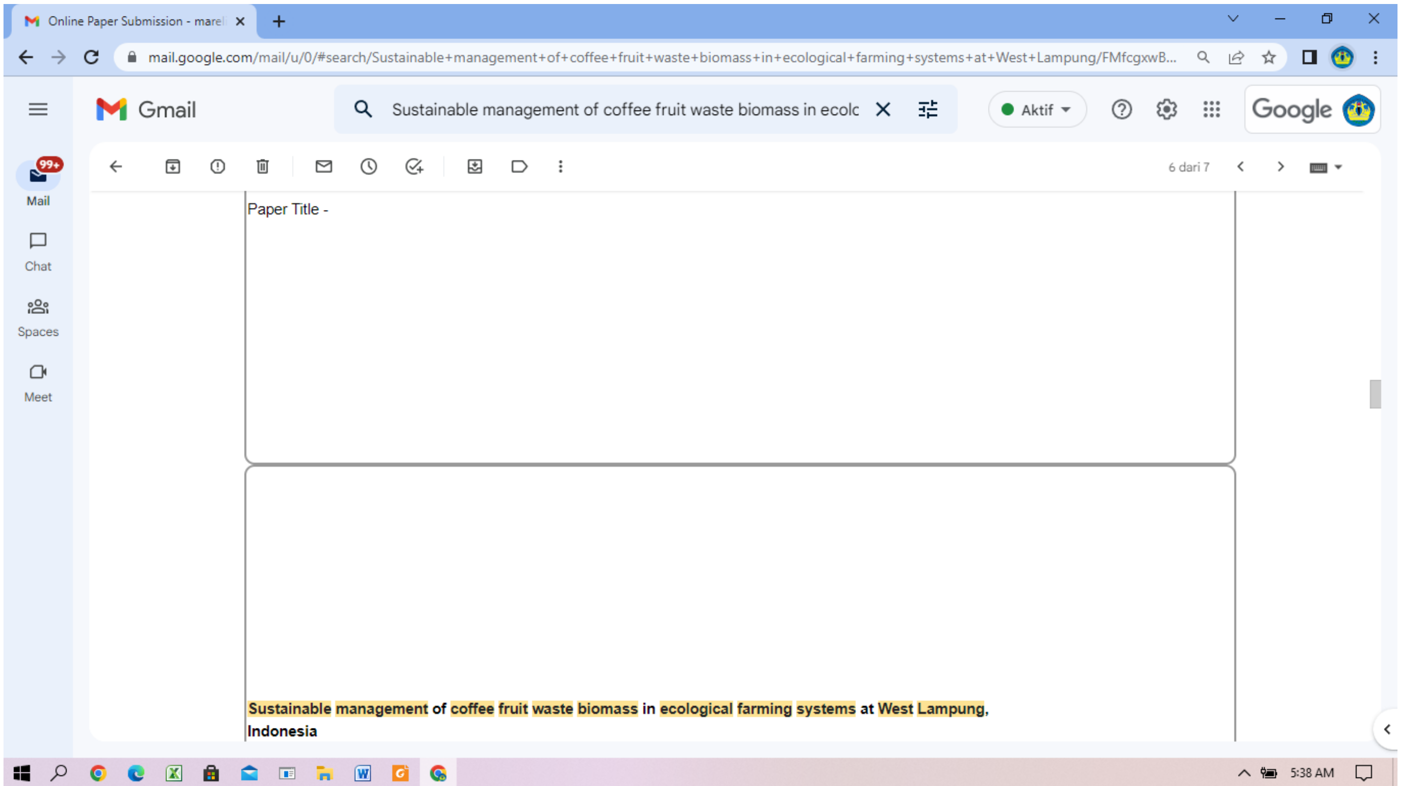
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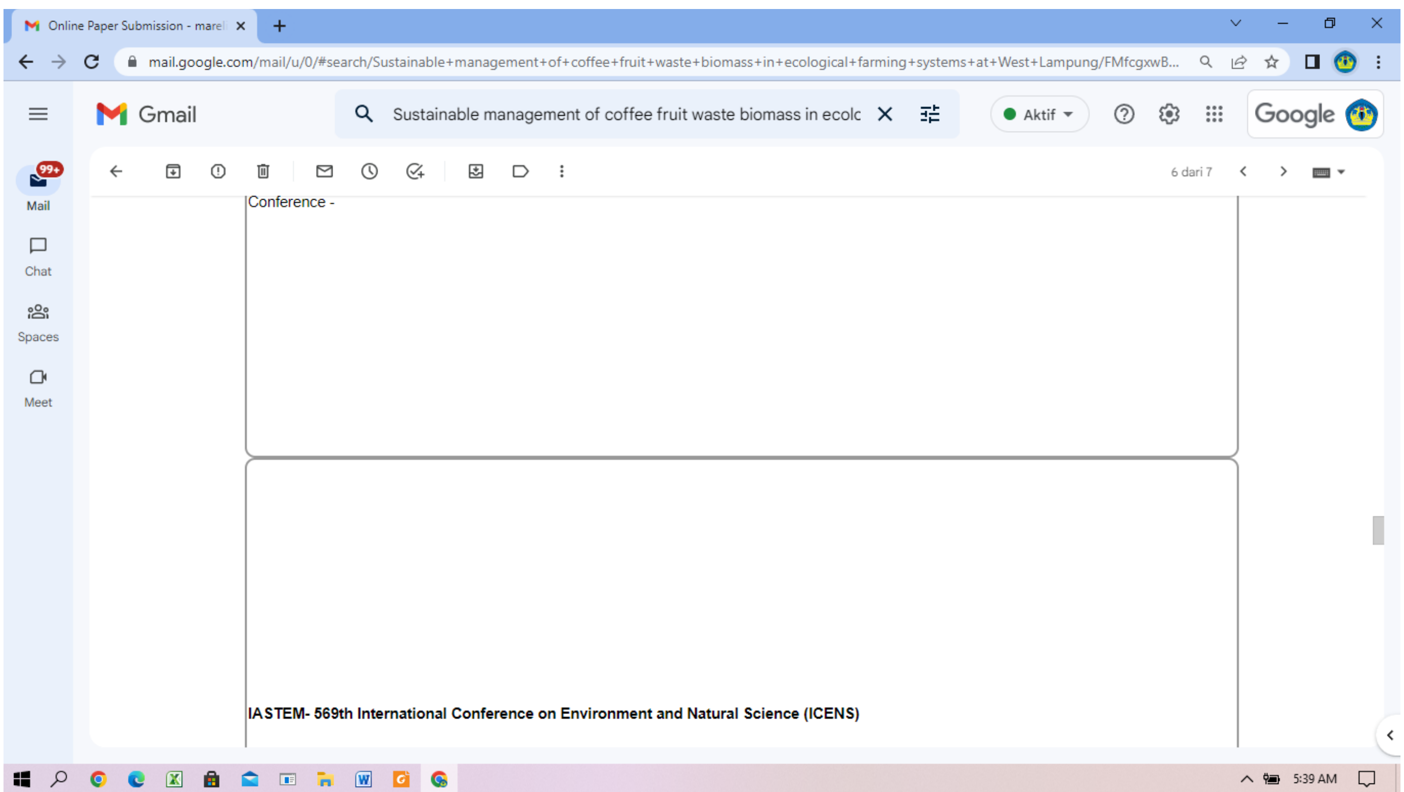
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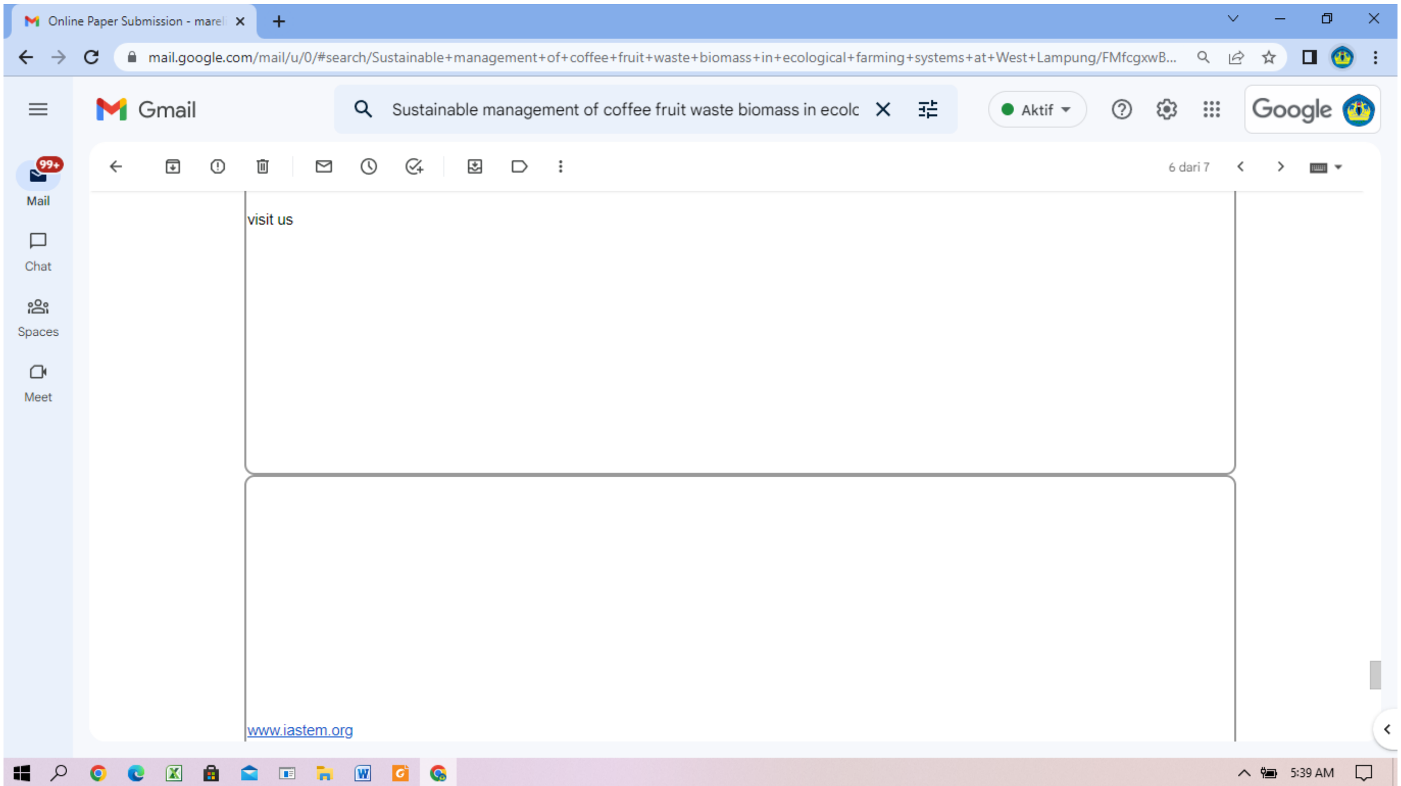

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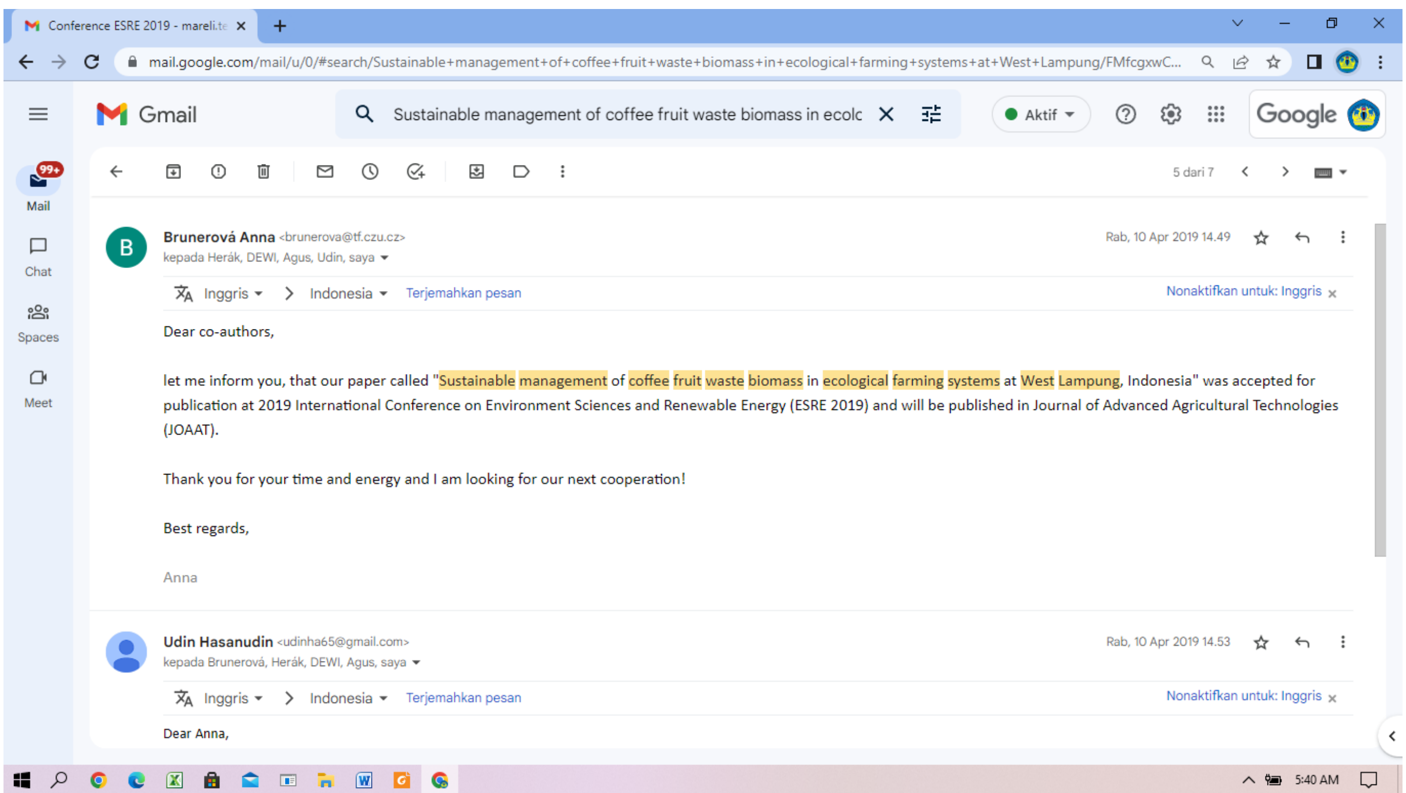

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Brunerová Anna <brunerova@tf.czu.cz> Rab, 10 Apr 2019 14.49
kepada Herák, DEWI, Agus, Udin, saya

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Dear co-authors,

let me inform you, that our paper called "Sustainable management of coffee fruit waste biomass in ecological farming systems at West Lampung, Indonesia" was accepted for publication at 2019 International Conference on Environment Sciences and Renewable Energy (ESRE 2019) and will be published in Journal of Advanced Agricultural Technologies (JOAAT).

Thank you for your time and energy and I am looking for our next cooperation!

Best regards,

Anna

Udin Hasanudin <udinha65@gmail.com> Rab, 10 Apr 2019 14.53
kepada Brunerová, Herák, DEWI, Agus, saya

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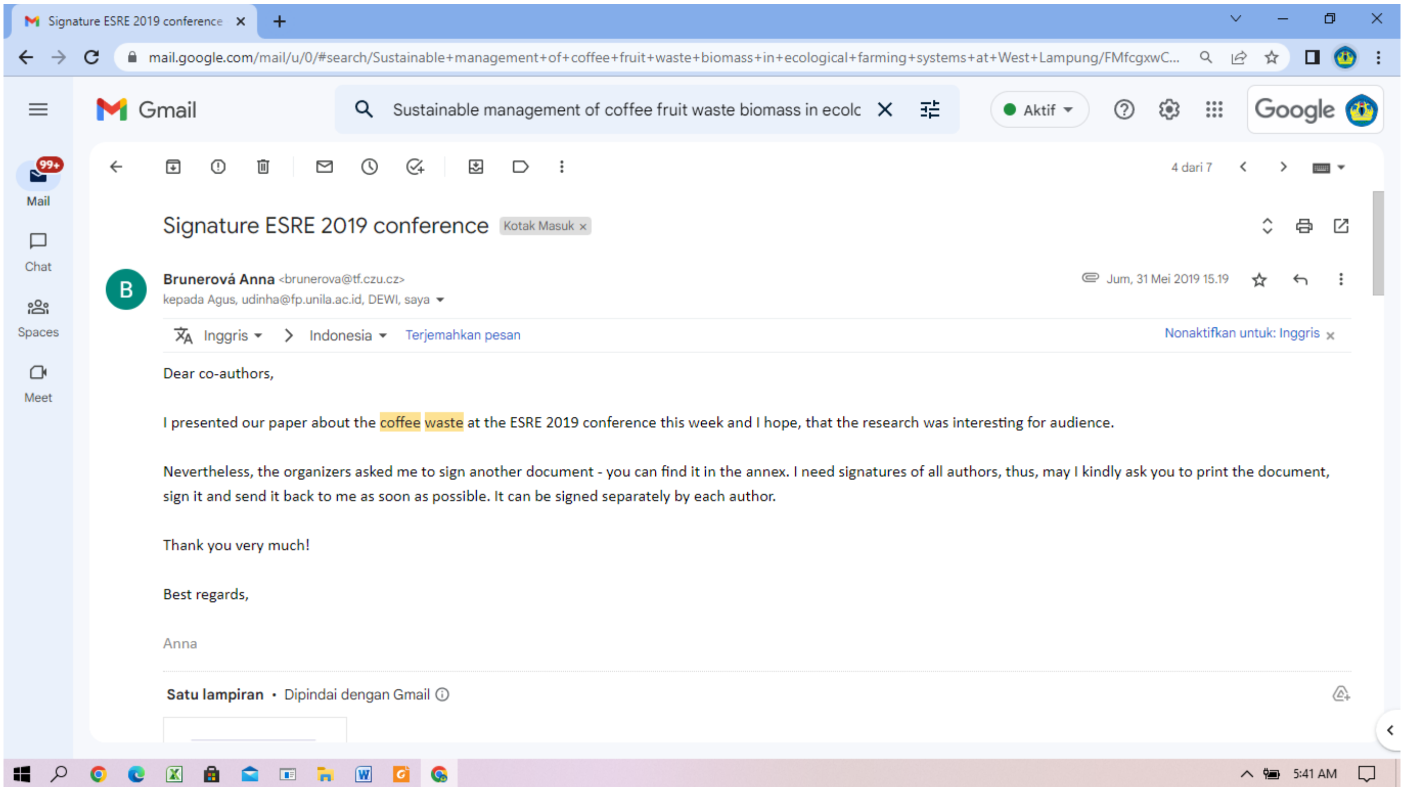

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Brunerová Anna <brunerova@tf.czu.cz>
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Dear co-authors,

I presented our paper about the coffee waste at the ESRE 2019 conference this week and I hope, that the research was interesting for audience.

Nevertheless, the organizers asked me to sign another document - you can find it in the annex. I need signatures of all authors, thus, may I kindly ask you to print the document, sign it and send it back to me as soon as possible. It can be signed separately by each author.

Thank you very much!

Best regards,

Anna

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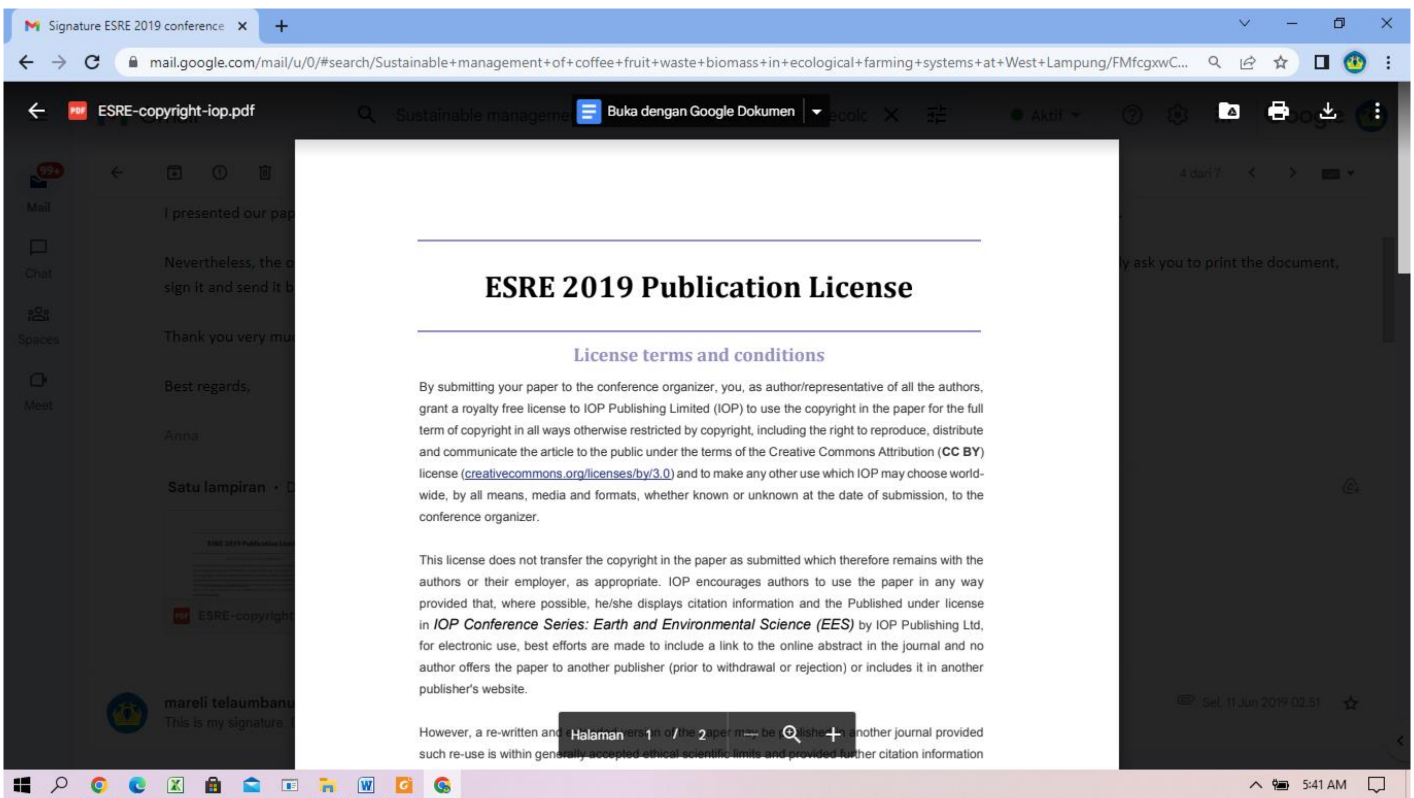

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Sustainable management of coffee fruit waste biomass in ecological farming systems at West Lampung, Indonesia

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Abstract—* *Present study focuses on fruit waste biomass generated during the postharvest treatments of coffee cherries (Coffea spp.) and its subsequent utilization within the waste-less, sustainable and ecological farming systems. Investigated samples were collected at the organic shaded multi-culture coffee plantations in West Lampung, Indonesia. Within the determination of most suitable subsequent utilization, the samples were subjected to the analysis of their basic chemical parameters, energy potential and ash composition. Three samples kinds were defined: I. CP (outer skin, pulp), II. CH (husk, silver skin, parchment) and III. CA (burned mixture of previous two waste materials). Obtained values proved following results; CP: M_c - 79.21%, A_c - 2.05%, CV - 17.19 MJ/kg; CH: M_c - 21.08%, A_c - 6.50%, CV - 18.14 MJ/kg; CA: M_c - 30.79%, A_c - 28.11%. Measured values proves the suitability of tested materials for combustion processes as a renewable source of clean energy (high energy potential), but also for the composting purposes (Potassium content K_2O - 10.946%). A great potential of tested materials within their subsequent reuse was proved, as well as the fact that they represent a commodity suitable for further valorization.

Index Terms— **agriculture residue, fruit waste biomass, calorific value, solid biofuel, renewable energy.**

I. INTRODUCTION

Indonesia is one of four biggest coffee producers; together with Brazil, Colombia and Vietnam produce approximately 50% of world production [1, 2].

Coffea arabica L. and *Coffea Robusta* L., the members of *Rubiaceae* family, represent the world well-known and favorite agriculture crops.

Postharvest treatment of raw coffee cherries contains primarily the de-pulping of green beans, i.e. removing of the outer skin, pulp and other internal layers. Whereas, such treatment generates a large quantity of biological residues (fruit waste biomass) [3]. In general, more than ten million tons of various agriculture residues in solid and liquid form is generated every year within the coffee agroindustry [1, 2].

According to previously published data, approximately one ton of fruit waste biomass is generated from two tons of raw coffee cherries [4]. If consider the current amount of coffee production in Indonesia (see Table I), it can be concluded, that coffee agroindustry participates in waste biomass production in large-scale.

Table I. Cultivation of green coffee beans in Indonesia [5]

Year	Harvested area (ha)	Yield (hg/ha)	Production (tonnes)
2014	1,230,500	5,233	643,900
2015	1,230,001	5,198	639,412
2016	1,228,512	5,204	639,305
2017	1,253,796	5,333	668,677

Thus, subsequent reuse of mentioned fruit waste biomass must be well managed and secured in effort to keep the proper waste management principals and to avoid to possible environmental damages. The necessity of such activities is undeniable and highly recommended within the reduction of the negative impact of the agriculture waste on the environment [1, 2]. Moreover, subsequent reusing of waste biomass do not represent only the proper waste management, it also offers the possibility of its financial valorization, because waste biomass also represents the valuable commodity [2].

Nowadays, a several different production sectors make an effort to find the most suitable and efficient strategies, how to reuse coffee fruit waste biomass [6]. The possibilities are very wide. Coffee pulp is occasionally used as a feedstock for livestock animals; however, the content of caffeine limits its utilization for such purposes due to the impacts on the animal health [7-9]. By using of the fermentation processes can be coffee pulp converted into the compost [10], as well as it can be used as a natural food colorant [11]. Antioxidants contained in the coffee pulp neutralize the free radicals, thus, can be uses as a prevention of various diseases [12-16].

Regarding to the biofuel research field, the bioethanol can be produced from coffee pulp by using of a digestion method [6, 17]. Biochemical characterization of investigated fruit waste biomass proved also its suitability for the production of first generation solid biofuel intended for direct combustion [1]. All of selected mentioned techniques seems attractive and relevant within the valorization and adding-value to investigated waste within the "Waste to energy" principles and strategies. Due to large-scale interest of human population in coffee products consummation, the knowledge about large-scale practical utilization of waste biomass from coffee industry is still in process. It is no exception that generated waste biomass and other by-products are left behind as an unused agriculture residue without further utilization, despite its great potential was proved [11].

Regarding to all facts mentioned above, the main aim of present paper was to investigated the chemical parameters of fruit waste biomass (coffee outer skin, pulp, silver skin and parchment) originated from ecological farming plantations and state the most efficient way of its sustainable utilization within the principal of materials return in to the environmental life cycle.

II. Methodology

Current chapter is divided into several sub-chapters ordered chronologically according to the sequences of performed research activities.

A. Materials and samples

Three different types of samples originating from the coffee cherry's (*Coffea* spp.) postharvest treatment were collected; namely, I. CP samples - outer skin and pulp (pericarp, exocarp and mesocarp), II. CH samples – husk, parchment and silver skin (endocarp and epidermis) and III. CA samples - burned mixture of previous two waste materials (CP samples + CH samples). For better visualization, see Figure I., which express the specific parts of coffee cherry.

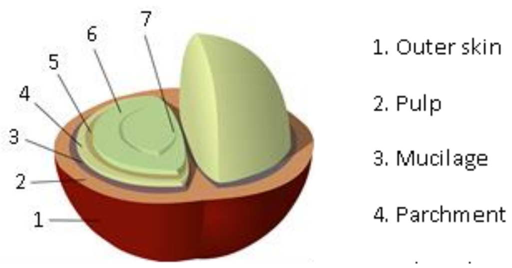

Figure I. Cross-section of raw unprocessed coffee cherry

Samples were collected during the rainy season in February 2019 at organic shaded coffee plantations placed in mountain areas of Hanakau city, Sukau district, West Lampung Regency, South Sumatra, Republic of Indonesia, as expressed in Figure II.

Figure II. The target area of samples collection

Collected samples of fruit waste biomass represented agriculture residue generated within the coffee agroindustry during the raw coffee cherries and green coffee beans treatment. Figure III. visualizes the unharvested coffee cherries and fruit waste biomass removed from raw coffee cherries in practice in the form of the agriculture residue left behind.

Figure III. Investigated samples: a) ripe raw coffee cherries, b) fruit waste biomass

Collected CP samples were removed from the raw coffee cherries by using of pulping machine (see Figure IV.: b)) directly after harvest and CH samples were collected after the process of green coffee beans natural sun drying (see Figure IV.: a)) and removing of skin remains. Thus, CP samples occurred in their initial moisture content, while CH samples were already sundried during drying process.

B. Experimental measurements

All measuring procedures described in present chapter were conducted to the mandatory technical standards, namely, ASTM International standards. Such standards define all details and specific steps of performed measurements, thus, they ensure their correctness and safety.

The laboratory experiments were performed within 7 days after the samples collection. Until then, the samples were hermetically preserved and stored in a cold place to prevent the change of their composition.

Figure IV. Postharvest treatment: a) sun dryer, b) pulping machine

Primarily, all samples were subjected to the determination of their basic chemical parameters, namely, moisture content M_c (%) and ash content A_c (%). Determination of M_c was performed by using of Laboratory oven Memmert, model UN55 (Schwabach, Germany), whereas, samples were dried for 24 hours at 102°C until their weight was constant. Determination of A_c was performed by using of Laboratory muffle furnace oven ISUZU, model EPTR-13K (Sanjo, Japan), while samples were dried at 600°C for 6 hours until the weight of ash was constant. Obtained values represented the differences between samples weight losses before and after experimental testing and were basis for the calculations of final results.

Further, the energy potential of CP and CH samples was stated by the determination of their calorific value CV (MJ/kg). Experimental measurements were performed by using of Oxygen Bomb Calorimeter, model CAL2K (Northcliff, South Africa), thereby, the samples were burned in the presence of Oxygen and CV was stated.

Finally, last part of the experiments was related to the coffee ash (CA samples) parameters, thus, the analysis of its mineral composition was performed by using of multi-functional instrument X-ray fluorescence (EDXRF) spectrometer PANalytical, model Epsilon 3XLE (Westborough, USA). The samples were burned in the presence of Oxygen, while the energy necessary for their burning was measured.

The forms of the samples during the experimental testing, thus, after drying process (moisture content M_c determination) and before crushing is visible at Figure V.

III. Results and Discussion

The results, which are described in present chapter, are expressed as an average values of several performed measurements due to their repetition (n=3). Parameters discussed in the chapter also represent quality indicators, which defined the suitability of samples for specific purpose.

Next part of the chapter is dealing with the cultivation procedures at target shaded multi-culture plantation due to its ecological, zero waste and sustainable principles. Specifically, the potential contribution of investigated fruit biomass materials in such ecological farming systems.

A. *Chemical quality indicators*

Primarily, analysis of basic chemical parameters of investigated samples defined their moisture content M_c (%) (as noted in Table II.).

Table II. Analysis of coffee waste samples parameters

Parameter	**Biomass sample**		
	CP	***CH***	***CA***
M_c (%)	79.21 ± 0.31	21.08 ± 0.06	30.79 ± 0.12
A_c (%)	2.05 ± 0.004	6.50 ± 0.24	28.11 ± 0.07
TS (%)	20.79 ± 0.31	78.92 ± 0.06	69.21 ± 0.12
VS (%)	18.74 ± 0.03	72.43 ± 0.30	41.10 ± 0.19
CV (MJ/kg)	17.19	18.14	-

± - standard deviation

All samples proved higher moisture content than is suitable for waste biomass intended for combustion processes (within potential solid biofuel conversion). High amount of moisture in sample (biofuel) leads to loss of energy output during burning, because energy is consumed by process of moisture vaporizing.

Thus, such results represent limitation in mentioned process. Nevertheless, countries like Indonesia have a great potential for sun drying technology due to their geographical location and climate conditions. The advantages of such technology can provide environmental friendly the solution within the waste biomass high moisture content issue; moreover, without the investment of other energy sources (electricity) by using only renewable energy form of sun power [18].

Figure V. Investigated samples: a) CP, b) CH, c) CA

Next quality indicator was ash content A_c (%), which defined the amount of ash in burning device after combustion. Thus, lower level of such indicator is required. Observed data proved satisfactory level (A_c < 10%) of ash content in case of CP and CH samples which is desired within combustion purposes. The CA samples were already burned at the plantation, thus, the result is not unbiased and were not be considered.

Energy potential of investigated samples was represented by the calorific value CV (MJ/kg) indicator. Both, the CP and CH samples, high level of calorific value, which is recommended for feedstock materials intended for solid biofuel production (CV ≥ 14.5 MJ/kg). Due to the characteristics of AC samples (previously burned), there were not use for the determination of calorific value.

A comparison of observed data with results of other authors is expressed in Table III. As visible, the results of moisture and ash content occur at similar values as was investigated in present research. Results of calorific values from literature review ranges from 11.60 to 24.07 MJ/kg, while measured data correspond approximately to the average of reported values.

Table III. Comparison of coffee pulp parameters

Indicator	Result	Reference
Ash content (%)	8.90	[19]
	1.50	[20]
	8.68	[21]
	5.47	[22]
	3.00	[23]
Moisture content (%)	81.40	[19]
	76.70	[20]
	90.00	[21]
	85.00	[16]
	77. 00	[24]
Calorific value (MJ/kg)	11.60 - 12.50	[21]
	17.67	[22]
	17.40	[25]
	23.72 - 24.07	[26]
	18.34	[27]

Result values of last investigated measurement (see Table IV.) described the mineral composition of samples ash (CA samples). Such analysis described the suitability of samples for several sustainable utilization; defines the suitability for composting technology or for utilization as a natural fertilizer. Moreover, describe possible problems during combustion process related to samples burning abilities and possible damages of burning device.

The inorganic content in biomass normally act as nutrients for living biological plants. The composition of ash strongly dependent on the plant species, growth and soil conditions. The data in Table IV. showed that concentration of CaO is dominated and higher than K_2O and SiO_2. High concentration value of alkaline earth such as Ca, Mg and K act as a soil liming agent and neutralize soil acidity, thus, it is advantageous to reuse such materials as a forest fertilizer, plant nutrient and soil conservation agent.

Table IV. Mineral composition of coffee waste biomass ash

Mineral composition	Result value	Unit
MgO	5.328	%
Al_2O_3	2.483	%
SiO_2	5.779	%
P_2O_5	7.830	%
SO_3	2.596	%
K_2O	10.946	%
CaO	60.191	%
TiO_2	0.358	%
V_2O_5	108.6	ppm
MnO	0.342	%
Fe_2O_3	3.150	%
CuO	0.235	%
ZnO	0.108	%
As_2O_3	11.6	ppm
Rb_2O	0.137	%
SrO	0.396	%
ZrO_2	49.1	ppm
SnO_2	705.3	ppm
TeO_2	251.9	ppm
PbO	69.1	ppm

% - percentage, ppm - parts per million

Knowledge about coffee fruit waste biomass chemical composition is necessary, if the material should represent commodity intended for subsequent valorization purposes. Therefore, Table V. express other detail analysis (and comparison) of ash content and mineral composition of coffee pulp reported by other author.

Table V. Coffee pulp ash content and mineral composition [28]

Mineral composition	Result value	Unit
Ash	8.3	g%
Ca	554	mg%
P	116	mg%
Fe	15	mg%
Na	100	mg%
K	1765	mg%
Zn	4	ppm
Cu	5	ppm
Mn	6.25	ppm
B	26	ppm

mg% - milligram per cent, ppm - parts per million

A. Ecological farming principles

Another aspect which must be considered, if evaluate the parameters and composition of investigated samples, are the cultivating conditions of their own growth. As was mentioned before, the samples originated from organic shaded coffee plantations. In general, coffee trees were not nourished or treated by any chemical fertilizers or agents (insecticides, herbicides, fungicides), which plays important role in ecological cultivation of coffee trees, further in composition of their fruit. Specifically, the waste biomass and ash, both originating from the plantations, were used as a natural fertilizer. Moreover, the specialized "shaded" method of cultivations represents ecological way of coffee trees preservation. Such method uses the principles of multi-culture farming when specific plants are used for preservation of other specific plants conditions. Selected plants live in symbiosis and support each other within the nutrient, growth, shade or insect repellent issues, thus, create a stable network of mutualistic interactions between each other [29-31].

Target plantations were cultivated by using of the intercropping principle; an areca palm (*Areca catechu* L.) specie was grown there as an intercrop intended to protect coffee trees against to abundance of sunshine and prevent of the water vaporization [32], see Figure VI.

Within the soil conservation were plantations protected by two cover crop species of Pinto Peanut (*Arachis pintoi*) of family *Fabaceae* and Black Pepper (*Piper Nigrum*) of family *Piperaceae*, which were cultivated under the coffee trees. Pinto Peanut is in ecological farming systems occasionally used as a living mulch. Which is related to its ability to fix nitrogen from the atmosphere and to grow in a shade of other cultivated plants [33]. Described multi-culture ecosystem is expressed in Figure VII.

Figure VI. Intercropping principle used at target plantation

Figure VII. Cover crops principle used at target plantation

Such interactions between specific cultivated plants are necessary and plays important role in specific ecosystem conservation and functionality of ecological farming systems without chemicals [28]. Using of such knowledge can replace the using of chemical substances in such ecosystems.

This, the suitable composition of waste biomass originating from ecological plantations is very important, because it represents the main source of plants nutrient which is used in closed waste-less farming systems.

IV. Conclusion

In the end, it can be concluded that coffee fruit waste biomass originating from postharvest treatments represents commodity with great potential within the ecological farming systems and returning into the nature life cycle (zero waste agriculture principles). To achieve such statement, the samples were subjected to the determination of their suitability for sustainable technologies and renewable energy production. Due to the results of basic chemical parameters, the ash content prove required low level, while moisture content proved undesired high level. Higher level of moisture content can represent the limitation within such waste biomass utilization, nevertheless, it can be easily improved solar drying technology. Energy potential determination proved suitability for direct combustion processes (solid biofuel production). Analyses of mineral composition proved advantage of investigated waste biomass for plant nutrient and soil conservation. In consequence, the ash from investigated fruit waste biomass is full-featured natural fertilizer. Such knowledge about sustainable mutli-culture organic farming and intercropping principles can leads to better understanding of mutualistic interactions between each crops, which can directly leads to decreasing of chemical fertilizers and agents utilization, which is highly recommended within the environmental conservation and consumers health issues.

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REFERENCES

[1] C. L. M. Martinez, E. P. A. Rocha, A. C. O. Carneiro, F. J. B. Gomes, L. A. R. Batalha, E. Vakkilainen and M. Cardoso, "Characterization of residual biomasses from the coffee production chain and assessment the potential for energy purposes," Biomass and Bioenergy, vol. 120, pp. 68-76, 2019.

[2] M. Echeverria and M. Nuti "Valorisation of the residues of coffee agro-industry: perspectives and limitations," Open Waste Management Journal, vol. 10, no. 1, pp. 13-22, 2017.

[3] A. Duangjaia, N. Suphrom, J. Wungrath, A. Ontawonga, N. Nuengchamnong and A. Yosboonruange "Comparison of antioxidant, antimicrobial activities and chemical profiles of three coffee (Coffea arabica L.) pulp aqueous extracts," Integrative Medicine Research, vol. 5, pp. 324–331, 2016.

[4] S. Roussos, M. de los Angeles Aquiáhuatl, M. del RefugioTrejo-Hernández, I. Gaime Perraud, E. Favela and M. Ramakrishna "Biotechnological management of coffee pulp isolation, screening, characterization, selection of caffeine degrading fungi and natural microflora present in coffee pulp and husk," Applied Microbiology and Biotechnology, vol. 32, pp. 756–762, 1995.

[5] Food and Agriculture Organization of the United Nations (FAO). 2019. Online. Accessed at 1st February 2019. Available at: http://www.fao.org/faostat/en/?#data/QC

[6] S. S. Harsono, M. Salahuddin, G. S. Fauzia, Purwono, D. Soemarno and Kissinger "Second Generation Bioethanol from Arabica Coffee Waste Processing at Smallholder Plantation in Ijen Plateau Region of East Java," Procedia Chemistry, vol. 14, pp. 408 - 413, 2015.

[7] B. K. G. Marcel, K. B. André, Z. T. Viviane and K. C. Séraphin "Potential food waste and by-products of coffee in animal feed," Electronic Journal of Biology, vol. 7, pp. 74-80, 2011.

[8] T. Salinas-Rios, M. E. Ortega-Cerrilla, M. T. Sánchez-Torres-Esqueda, J. Hernández-Bautista, A. Díaz-Cruz, J. L. Figueroa-Velasco, R. Guinzberg-Perrusquía and J. L. Cordero-Mora "Productive performance and oxidative status of sheep fed diets supplemented with coffee pulp," Small Ruminant Research, vol. 123, pp. 17-21, 2015.

[9] B. A. Ferreira, A. P. Aguilar, O. J. Pérez, V. B. Dos Santos and C. R. Maciel "Antinutritional factors of the hull and dehydrated pulp of coffee (Coffea arabica L.) stored in different periods," Revista Brasileira de Zootecnia, vol. 30, pp. 1325-1331. 2001.

[10] G. Sánchez, E. J. Olguín and G. Mercado "Accelerated coffee pulp composting," Biodegradation, vol. 10, pp. 35-41, 1999.

[11] P. S. Murthy and M. M. Naidu "Sustainable management of coffee industry by-products and value addition-a review," Resources, Conservation & Recycling, vol. 66, pp. 45-58, 2012.

[12] M. A. Arellano-González, A. R. Amírez-Coronel, T. Torres-Mancera, G. G. Pérez-Morales and G. Saucedo-Castañeda "Antioxidant activity of fermented and nonfermented coffee (Coffea arabica) pulp extracts," Food Technology and Biotechnology, vol. 49, pp. 374-378, 2011.

[13] L. A. Pham-Huy, H. He and C. Pham-Huy "Free radicals, antioxidants in disease and health" International Journal of Biomedical Science, vol. 4, pp. 89–96, 2008.

[14] A. A. P. Almeida, A. Farah, D. A. Silva, E. A. Nunan and M. B. A. Glória "Antibacterial activity of coffee extracts and selected coffee chemical compounds against enterobacteria," Journal of Agricultural and Food Chemistry, vol. 54, pp. 8738-8743, 2006.

[15] G. Runti, S. Pacor, S. Colomban, R. Gennaro, L. Navarini and M. Scocchi "Arabica coffee extract shows antibacterial activity against Staphylococcus epidermidis and Enterococcus faecalis and low toxicity towards a human cell line," LWT - Food Science and Technology, vol. 62, pp. 108–114, 2015.

[16] C. Monente, J. Bravo, A. I. Vitas, L. Arbillaga, M. P. De Peña and C. Cid "Coffee and spent coffee extracts protect against cellmut agens and inhibit growth of food-borne pathogen microorganisms," Journal of Functional Foods, vol. 12, pp. 365–374, 2015.

[17] D. Shenoy, A. Pai, R. K. Vikas, H. S. Neeraja, J. S. Deeksha, C. Ch. Nayak and V. Rao "A study on bioethanol production from cashew apple pulp and coffee pulp waste," Biomass and Bioenergy, vol. 35, pp. 4107-4111, 2011.

[18] O. V. Ekechukwu and B. Norton "Review of solar-energy drying systems II: an overview of solar drying technology," Energy Conversion & Management, vol. 40, pp. 615-655, 1999.

[19] B. Janissen and T. Huynh "Chemical composition and value-adding applications of coffee industry by-products: A review," Resources, Conservation and Recycling, vol. 128, pp. 110-117, January 2018.

[20] J. E. Braham and R. Bressani "Coffee pulp: composition, technology, and utilization," The International Development Research Centre, Ottawa, Canada, IDRC-108e, 1979. ISBN: 0-88936-190-8.

[21] R. Cubero-Abarca, R. Moya, J. Valaret and M. T. Filho "Use of coffee (coffea arabica) pulp for the production of briquettes and pellets for heat generation," Ciência e Agrotecnologia, vol. 38, no.5, pp.461-470, 2014.

[22] M. W. Mbugua, M. W. Kimani, B. N. K. Njoroge, A. N. Gitau, J. M. Mutua and A. K. Luvai "Characterization of the Physical Parameters of Coffee Husks towards Energy Production," International Journal of Emerging Technology and Advanced Engineering, vol. 4, no. 9, pp. 2250-2459, 2014.

[23] M. Arya and L. J. M. Rao "An impression of coffee carbohydrates," Critical reviews in food science and nutrition, vol. 47, no. 1, pp. 51-67, 2007.

[24] B. Murillo, M. T. Cabezas, R. Jarquin and R. Bressani "Effect of bisulfite addition on the chemical composition and cellular content fractions of dehydrated coffee pulp," Journal of Agricultural and Food Chemistry, vol. 25, no. 5, pp. 1090-1092, 1977.

[25] C. Ploypradub, B. Cheamsuphakit and Punbusayakul N. "Antioxidant properties of different parts of arabica coffee berry and spent coffee ground," Journal of Agricultural Science, vol. 41, pp. 577–580, 2010.

[26] A. Zuorro and R. Lavecchia "Spent coffee grounds as a valuable source of phenolic compounds and bioenergy," Journal of Cleaner Production, vol. 34, pp. 49-56, 2012.

[27] C. F. Mhilu "Analysis of Energy Characteristics of Rice and Coffee Husks Blends," Chemical Engineering, ISRN Chemical Engineering, vol. 2014, Article ID 196103, 6 pages, 2014.

[28] R. Bressani, E. Estrada and R. Jarquin "Pulpa y pergamino de cafe I. Composicion quimica y contenido de aminoacidos de la proteina de la pulpa," Turrialba, vol. 22, no. 3, pp. 229-304, 1972.

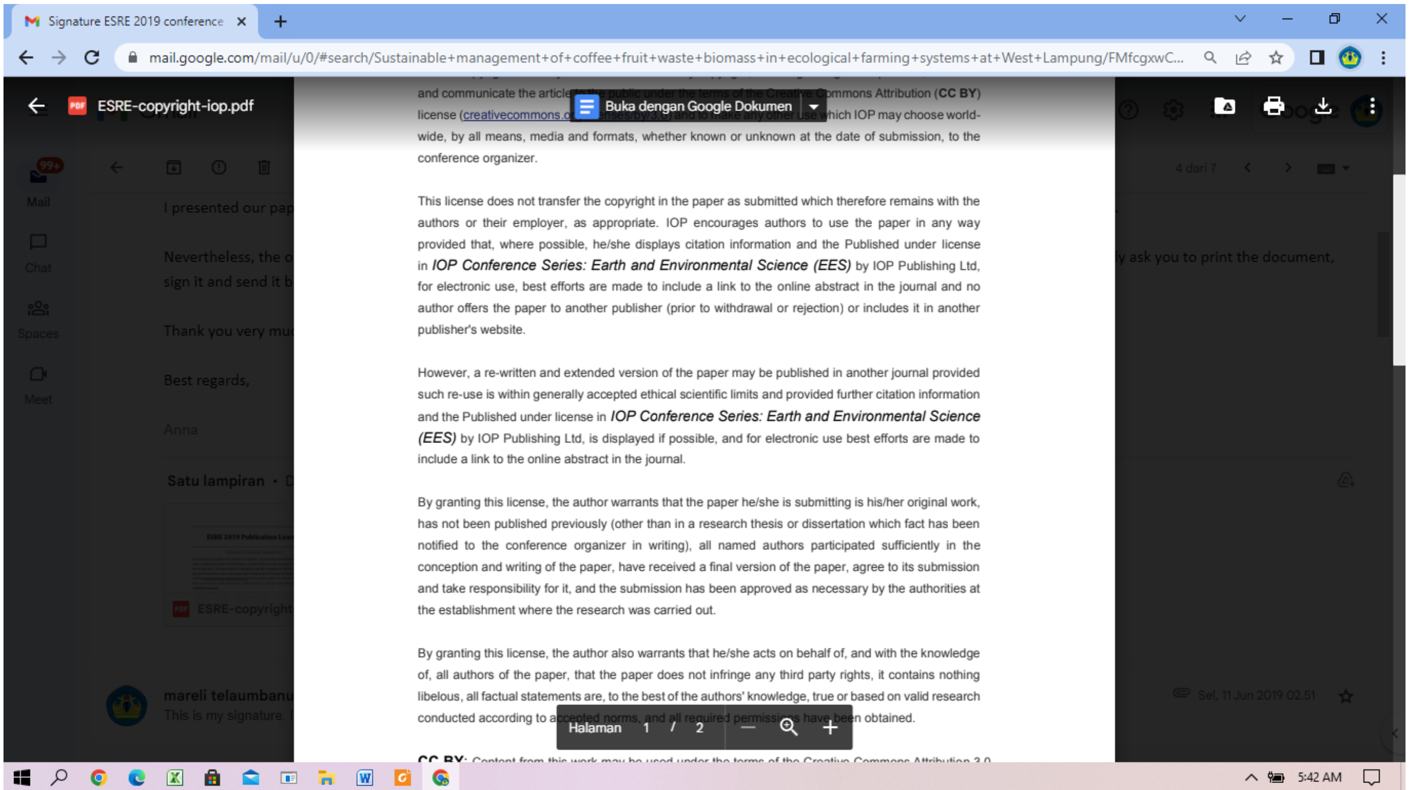
[29] A. Valiente-Banuet and M. Verdú "Human impacts on multiple ecological networks act synergistically to drive ecosystem collapse," Frontiers in Ecology and the Environment, vol. 11, pp. 408–413, 2013.

[30] J. M. Tylianakis, E. Laliberté, A. Nielsen and J. Bascompte "Conservation of species interaction networks," Biological Conservation, vol. 143, pp. 2270–2279. 2010.

[31] N. Blüthgen and A. M. Klein "Functional complementarity and specialisation: The role of biodiversity in plant-pollinator interactions," Basic and Applied Ecology, vol. 12, pp. 282–291, 2011.

[32] S. Sujatha, R. Bhat, C. Kannan and D. Balasimha "Impact of intercropping of medicinal and aromatic plants with organic farming approach on resource use efficiency in areca nut (Areca catechu L.) plantation in India," Industrial Crops and Products, vol. 33, pp. 78–83, 2011.

[33] J. G. Kartika, M. R. Reyes and A. D. Susila "Review of Literature on Perennial Peanut (Arachis pintoi) as Potential Cover Crop in the Tropics," The Sustainable Agriculture and Natural Resource Management (SANREM) Knowledgebase, 2007.



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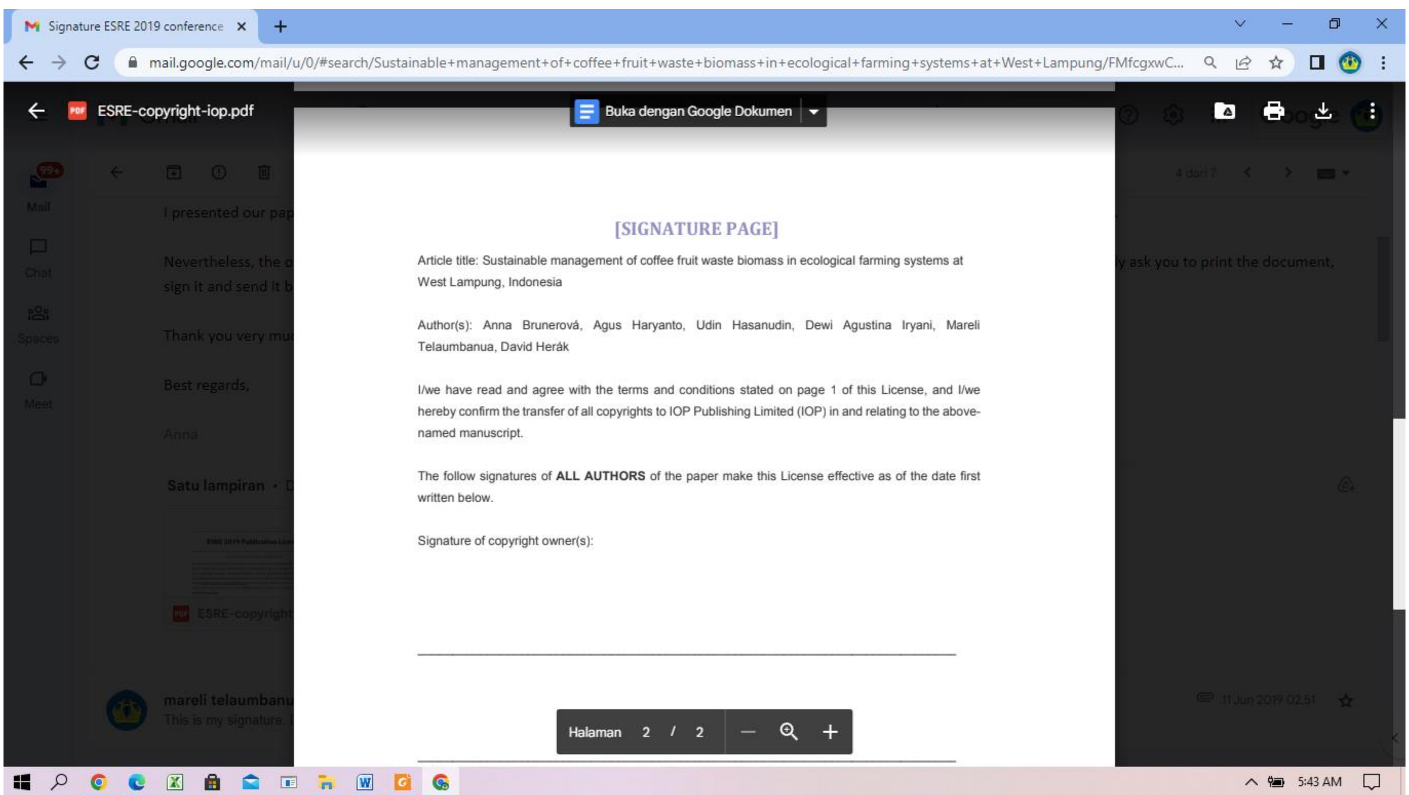

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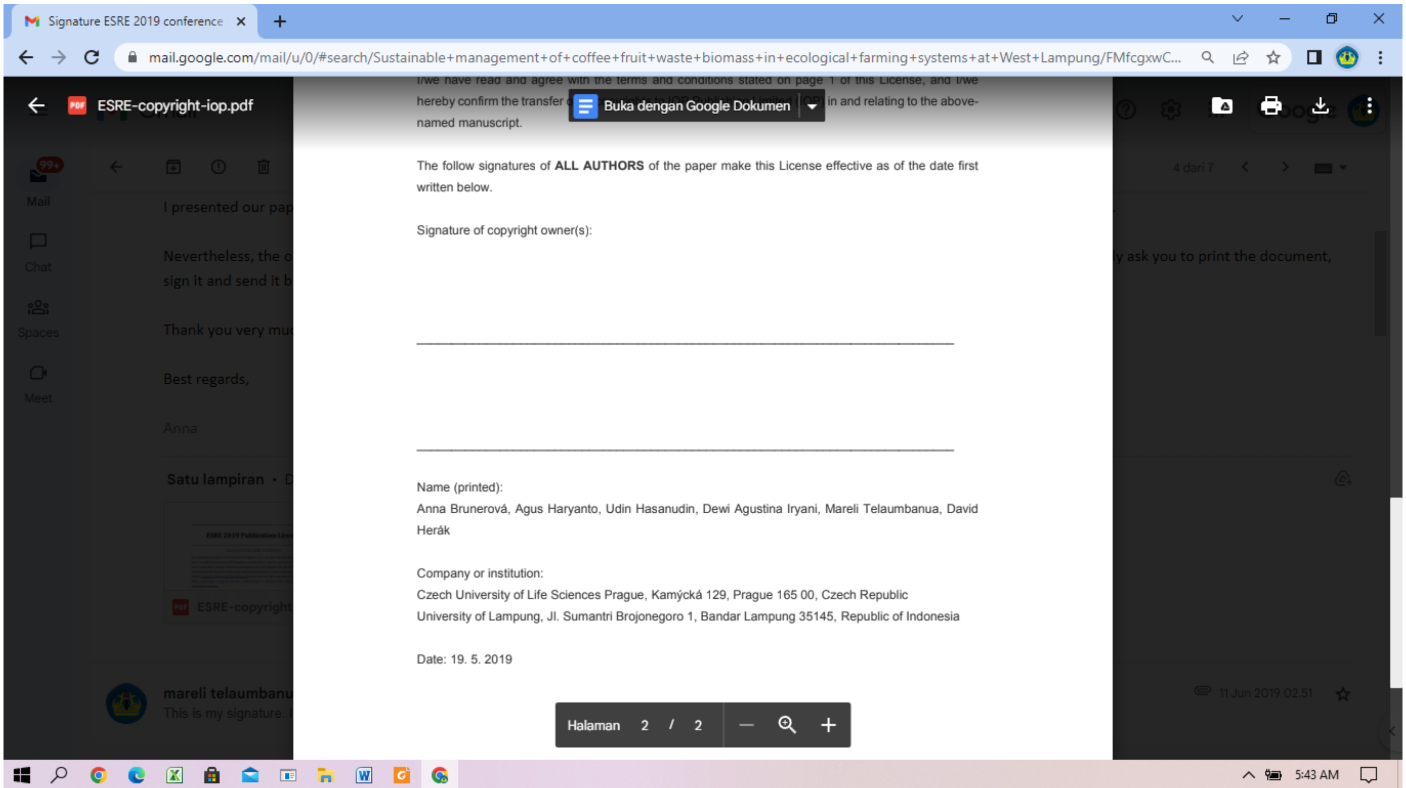
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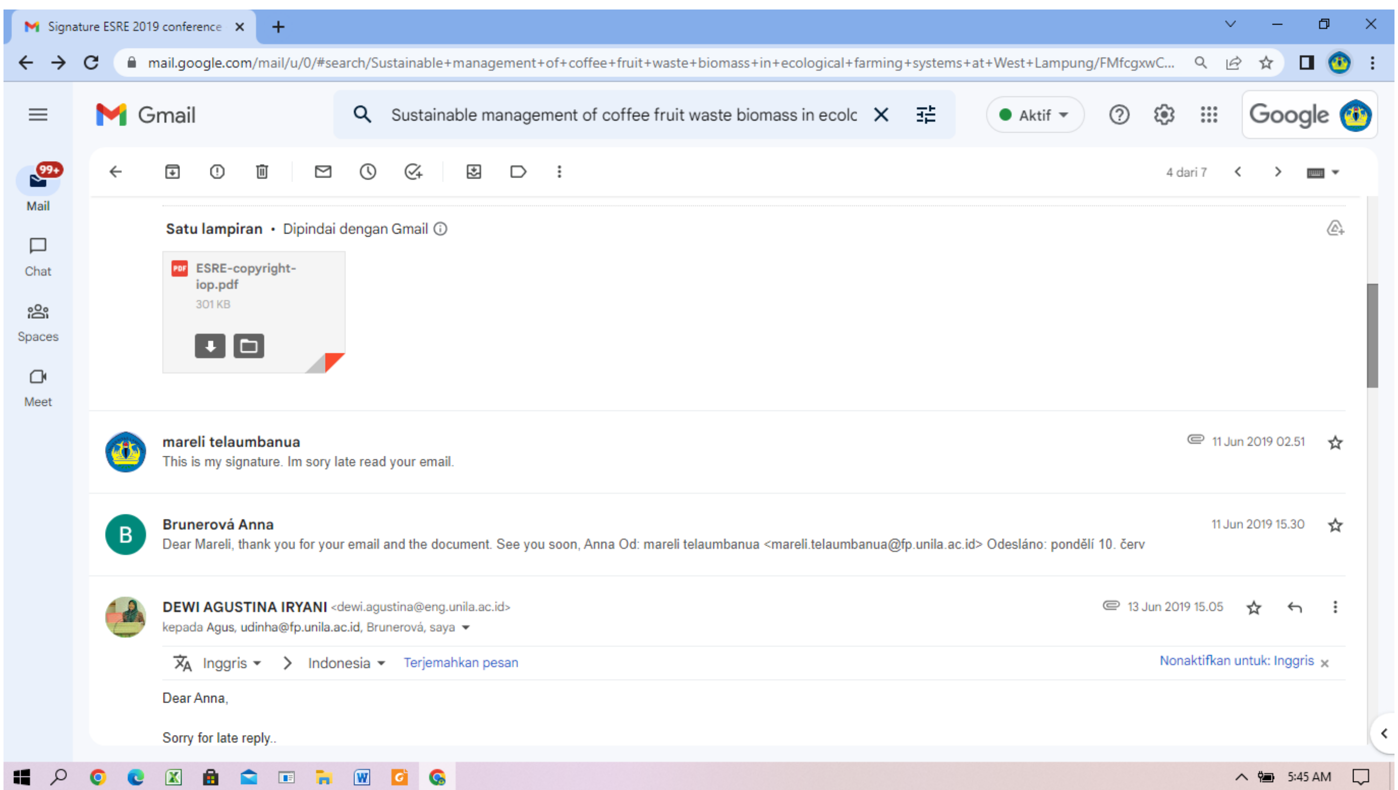
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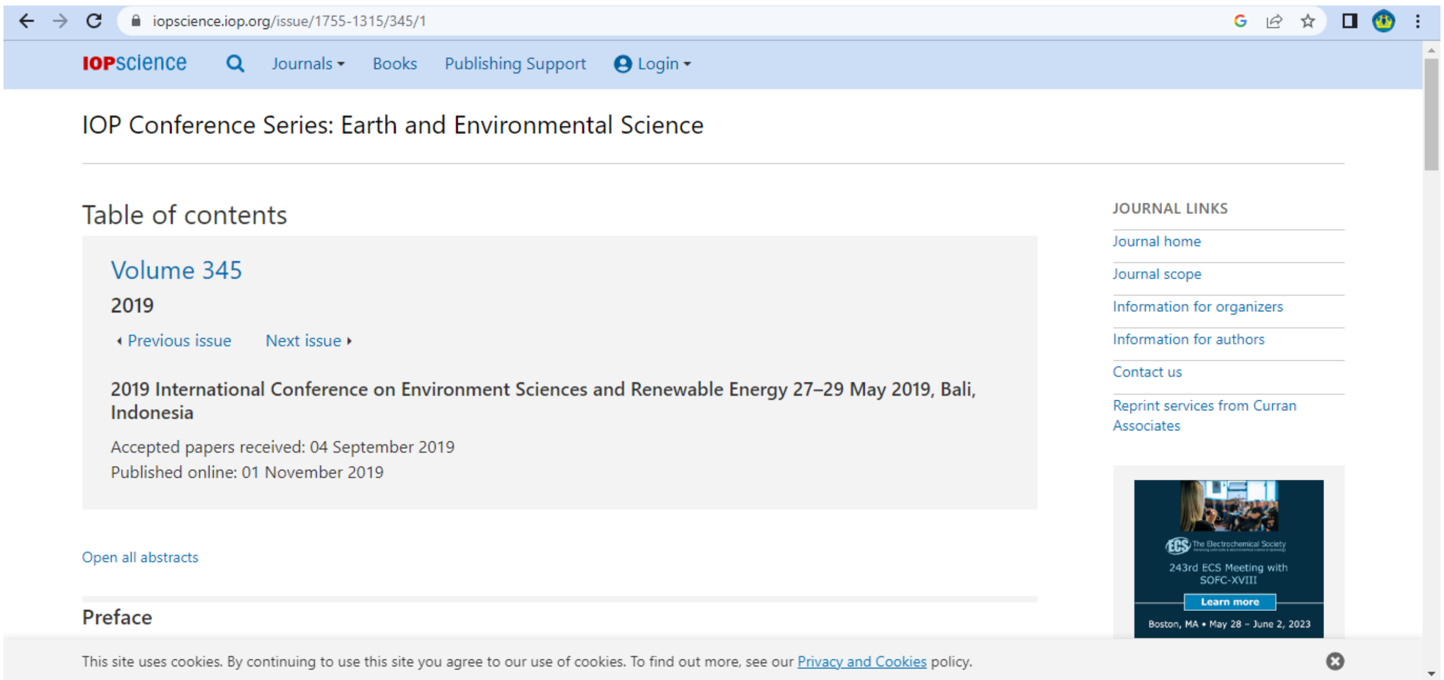

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