University of Belgrade
Technical Faculty in Bor
Mining and Metallurgy
Institute Bor

56th International October Conference on Mining and Metallurgy

PROCEEDINGS

Editors:
Ljubiša Balanović
Dejan Tanikić

22-25 October 2025,
Bor Lake, Serbia

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PREFACE

On behalf of the Organizing Committee, it is a great honor and pleasure to welcome all esteemed participants of the **56th International October Conference on Mining and Metallurgy (IOC 2025)**, scheduled to take place at **Bor Lake, Serbia**, from **October 22nd to 25th, 2025**.

The collaborative efforts of the University of Belgrade – Technical Faculty in Bor and the Mining and Metallurgy Institute Bor have once again brought together academia, industry, and research institutions to organize this year's IOC. Our focus remains firmly set on presenting the latest research achievements and technological advancements in geology, mining, metallurgy, materials science, technology, environmental protection, and other engineering disciplines.

This year's conference program is rich and diverse, featuring **4 plenary lectures, 4 invited lectures, 158 full papers, and 6 abstracts**. The proceedings reflect the contributions of authors from **19 countries**: Austria, Bosnia and Herzegovina, Bulgaria, Canada, China, Croatia, Germany, Hungary, India, Mexico, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Turkey, and the United Kingdom. Among the submitted papers, eight young researchers under the age of 35 have qualified to participate in the "**MDPI Young Researcher Award**" competition, further emphasizing the conference's commitment to supporting and recognizing excellence among the new generation of scientists and engineers.

We are also delighted to host the **9th International Student Conference on Technical Sciences (ISC 2025)**, running in parallel with IOC 2025. The student conference brings together young researchers from Serbia and the wider region, with **one plenary** and **50 student papers** presented, offering an invaluable opportunity for the next generation of scientists and engineers to share their ideas and discuss the future of their disciplines with experts. The "**Professor Dragana Živković Best Student Paper Award**" will be presented to the most outstanding student contribution based on originality, research quality, and presentation.

The Organizing Committee expresses its deepest gratitude to all who have supported this event. Our General Sponsor is the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia. We are especially grateful to our Platinum Donors, HBIS Serbia and Serbia Zijin Mining, as well as our Gold Sponsor, DPM Metals Inc., and our Gold Donors, Copper Mill Sevojno and Serbia Zijin Copper Bor. This year, the conference is also supported by the Silver Donor, "MC LABOR" d.o.o. Beograd.

We proudly host a diverse exhibition, featuring Indemak, Labtim SE d.o.o., MERIS d.o.o., Krug International LTD, Altium International d.o.o., Metalurg Foundry Ltd., Fugro Germany Land GmbH, Analysis d.o.o., Lola institut, Tescan and Mikrolux d.o.o., Trokuttest Serbia, Novos d.o.o., Changsha Rui Rui Technology Co., Ltd., MDPI and the Winery of Bukovo Monastery. The official opening of the conference has been supported by Epiroc Srbija a.d.. Finally, we warmly acknowledge our Friends of the Conference: Messer Tehnogas AD Belgrade, the China-Serbia Joint Laboratory on Green Steel Manufacturing, and the Foundation B.Sc. Boško Injac.

We sincerely thank all authors, committees, reviewers, speakers, and chairpersons for their invaluable contributions to shaping IOC 2025. We are confident that the conference will once again serve as a alive platform for scientific exchange, professional networking, and the promotion of sustainable development in mining, metallurgy, and related fields.

On behalf of the 56th IOC Organizing Committee,
Prof. dr Ljubiša Balanović

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Original scientific paper

ANALYSIS OF THE ENERGY POTENTIAL OF BRIQUETTES MADE FROM GROUND PLUM, DATE, AND AVOCADO PITS

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Abstract

This paper presents an analysis of the energy potential of briquettes made from ground plum pits. The higher and lower calorific values of briquettes produced from ground plum pits were determined experimentally. To assess the energy potential more comprehensively, the calorific values of briquettes made from date and avocado pits were also determined. Based on the results presented, briquettes made from date pits have an average calorific value of around 19 MJ/kg, placing them in the same range as certain types of wood. Plum pit briquettes exhibit even higher energy potential, exceeding 21 MJ/kg, while avocado pit briquettes show a slightly lower value, around 16 MJ/kg. The results indicate that briquettes made from plum, date, and avocado pits possess notable energy potential, though sample preparation is essential to achieve maximum efficiency.

Keywords*: briquettes, plum pits, calorific value of solid fuel*

1. INTRODUCTION

The issue of ensuring an adequate energy supply ranks immediately after food supply in terms of importance. Biomass as a fuel can be used effectively to generate thermal energy, especially by small and medium-sized consumers located at or near the site of biomass production. Numerous organic materials can be used to produce environmentally friendly fuels, including straw from various cereals, soya and rapeseed residues, maize stalks, sunflower stalks, pruning residues from orchards and vineyards, and fruit stones and peel [1]. Waste biomass in the form of plum pits represents a high-quality fuel class. Although this fuel can be used in bulk form, combustion problems can occur due to particles falling through the grate. To overcome these problems, plum pits are subjected to briquetting.

The aim of this study is to determine the energy potential of residues from plum processing used as a fuel source. For this purpose, the high and low calorific values of briquettes made from ground plum pits are determined. In order to evaluate the energy potential of briquettes made from ground plum pits, their calorific value is compared with that of briquettes made from date and avocado pits, whose calorific values were also determined experimentally. In addition, literature data is available for peach and apricot kernels [2].

2. DETERMINATION OF THE CALORIFIC VALUE OF SOLID FUELS

The calorific value of a fuel is defined as the ratio between the amount of heat released during complete combustion and the amount of fuel from which the heat is generated [3]:

$$H = Q / m_g , \tag{1}$$

where: H - calorific value of the fuel in kJ/kg, Q - amount of heat released in kJ and m_g - mass of the fuel in kg.

The higher calorific value or gross calorific value (H_g) of a fuel is the amount of heat released during the complete combustion of a unit mass of the fuel, assuming that the water produced during combustion remains in the liquid state. The lower calorific value (H_d) is the amount of heat released during the complete combustion of a unit mass of a fuel, assuming that the water produced during combustion remains in the gaseous state.

The calorific value of solid fuels is determined using a bomb calorimeter. The procedure is as follows: A certain amount of water is poured into the calorimetric bomb. A crucible with a measured mass of fuel is placed on a base and an ignition wire is embedded in the fuel, the ends of which are connected to the ignition terminals. The bomb is sealed, filled with oxygen to a certain pressure and placed in the calorimetric vessel with a measured quantity of water so that the bomb is completely submerged. After connecting the electric ignition cables to the lid of the bomb, the calorimeter is sealed and the stirrer is activated. A thermometer is immersed in the water. As soon as the water temperature has stabilized, the fuel is ignited. The heat released during combustion is transferred to the surrounding water and the rise in temperature is recorded. Combustion is considered complete when no soot is visible on the walls of the bomb and no unburnt carbon remains in the crucible.

The determination of the higher calorific value of solid fuels with a bomb calorimeter is based on the complete combustion of a measured amount of fuel in an oxygen-rich atmosphere, under increased pressure and constant volume. The heat generated by the combustion is transferred to the surrounding medium, i.e. the water. By measuring the mass of the water and the rise in temperature, the amount of heat released can be calculated:

$$Q = m_v \cdot c_v \cdot \Delta t_v \, , \tag{2}$$

where: Q - amount of heat released in kJ, m_v - mass of water in kg, c_v - specific heat capacity of water, whose value is 4.2 kJ/(kg°C) and Δt_v - increase in water temperature in °C.

Based on the determined amount of heat released and the mass of the fuel, the calorific value of the fuel is calculated using the following equation (1):

$$H_g = \frac{C \cdot \Delta t_v - Q_z}{m_g} \, , \tag{3}$$

where: H_g - higher calorific value of the fuel in kJ/kg, C - calorimeter constant in J/°C, Δt_v - increase in water temperature in °C, Q_z - the amount of heat generated by the combustion of the wire in J and m_g – mass of the fuel in g.

The hygroscopic moisture content of the fuel is calculated using the following formula

$$W_H = \frac{m_1 - m_2}{m_1} \cdot 100 \, , \tag{4}$$

where: W_H - hygroscopic moisture content in %, m_1 - initial mass of the fuel sample in g i m_2 - measured mass of the fuel sample after drying in g.

The lower calorific value of the fuel is calculated using the following equation:

$$H_d = H_g - 25 \cdot (9 \cdot H + W_G + W_H) \, , \tag{5}$$

where: H_d - lower calorific value of the fuel in kJ/kg, H_g - higher calorific value of the fuel in kJ/kg, W_G - gross moisture content, expressed in %, is not normally taken into account as it is assumed that the gross moisture has already been removed from the fuel, W_H - hygroscopic moisture content in % and H - hydrogen content of the fuel sample in %.

3. RESULTS AND DISCUSSION

The briquettes shown in Figure 1 were produced by drying plum pits at 100°C for 12 hours and then grinding them into powder using a ceramic mill. This was followed by the briquetting process, i.e. filling the mould and applying compression. The resulting briquettes diameter is 10.5 mm.

Figure 1. Briquetting of plum pits

The calorific value of the plum briquettes was measured with a Berthold-Mahler type bomb calorimeter (manufacturer: LABOUR) in the Laboratory of Propulsion Materials at the Faculty of Engineering, University of Kragujevac. The measurement results are shown in Table 1.

Table 1: Determination of the calorific value of solids according to SRPS ISO 1928:2022

Information on the test substance			
Type of substance: pits	plum	date	avocado
Moisture content: *W* [%]	5.5	5	5
Hydrogen content: *H* [%]	5.9*	5.9*	5.9*
Details of the measuring device			
Water equivalent of the device: m_e [g]	450.9	450.9	450.9
Mass of water in the calorimeter: m_w [g]	2800	2800	2800
The amount of heat generated by the combustion of the wire: q_z [J/g]	6698.5	6698.5	6698.5
Specific heat capacity of water: c_w [J/(gK)]	4.186	4.186	4.186
Results of the measurement			
Mass of the sample of the test substance: m_g [g]	2.323	1.588	1.791
Mass of the wire: m_{z1} [g]	0.056	0.063	0.05
Mass of the unburnt wire: m_{z2} [g]	0.016	0.014	0.011
Mass of the water in bomb: m_b [g]	10	10	10
Calculations			
Corrected temperature change during the main measurement period: Δt [°C]	3.66	2.236	2,123
The amount of heat generated by the combustion of the wire: $Q_z = (m_{z1} - m_{z2}) \cdot q_z$, [J/g]	267.94	328.227	261,241
Higher calorific value of the test substance: $H_g = \frac{c_w \cdot \Delta t \cdot (m_e + m_w + m_b) - Q_z}{m_g}$, [J/g]	21391	19014	16035
Lower calorific value of the test substance: $H_d = H_g - 25 \cdot (9 \cdot H + W)$, [J/g]	19926	17562	14583

*(literature reference)

Figure 2 shows a graphical representation of the results obtained in Table 1.

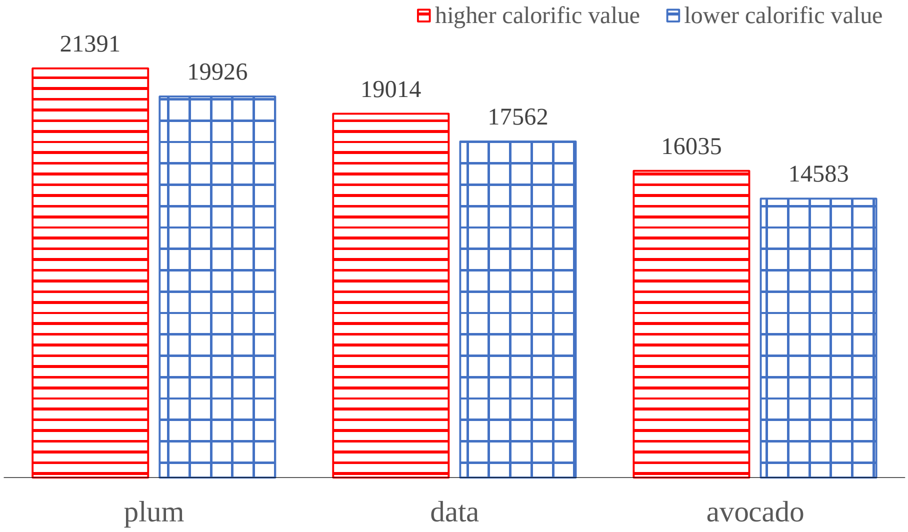

Figure 2: Higher and lower calorific values of briquettes made from plum, date and avocado pits

Based on the results shown in Figure 2, briquettes made from plum pits have the highest calorific value, followed by briquettes made from date kernels, while briquettes made from avocado kernels have the lowest calorific value. The results indicate that briquettes made from plum, date and avocado pits have some energy potential; however, proper sample preparation is required to maximize efficiency.

4. CONCLUSION

Plum, date and avocado pits are produced in large quantities as waste during the processing of these fruits in the food industry. Instead of ending up in landfill sites, these pits can be utilized as valuable raw materials for briquette production.

The analysis presented in this study shows that briquettes made from date pits have an average calorific value of around 19 MJ/kg, which is on a par with certain types of wood. Plum pit briquettes are even more energy-rich with a potential of up to 21 MJ/kg, while avocado pit briquettes have a slightly lower value of around 16 MJ/kg.

Briquettes made from ground plum, date and avocado pits are a promising and sustainable source of energy. Their production and use can contribute significantly to reducing dependence on fossil fuels and improving energy efficiency, while having a positive impact on the environment.

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