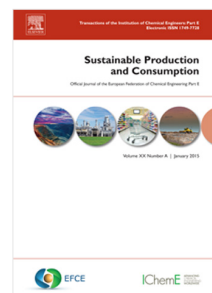


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Assessment of energy and exergy efficiencies and renewability of black tea, instant tea and ice tea production and waste valorization processes

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2 **Assessment of energy and exergy efficiencies and renewability of black tea,**
3 **instant tea and ice tea production and waste valorization processes**

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13 **ABSTRACT**

14 Cumulative degree of perfection (CDP), cumulative carbon dioxide emission (CCO₂E) and
15 renewability indicator (RI) are employed as tools to assess sustainability of packaged black
16 tea, instant tea and ice tea production processes and valorization of their waste. The black tea
17 production process, when there is no waste, had the highest CDP and the renewability
18 indicator RI, with CDP = 0.425 and RI = -1.35. The CDP was 0.013 and RI was -31.30 with
19 the instant, and CDP = 0, RI = -610,668 with the ice tea production processes. When activated
20 carbon, hydrogen and adsorbent material were produced from the waste of the instant tea, the
21 CDP increased to 0.087, 0.035 and 0.172, respectively; in these cases, the RI increased to -
22 10.53, -27.90 and -4.83, respectively. The negative RI values indicate non-renewability of the
23 processes. Increase in the positive CDP and the decrease in the negative RI values show that
24 when adsorbent material production from waste was done together with instant tea
25 production, substantial improvement may be achieved. Similar improvements may also be
26 achieved in the case of ice tea production when the waste is subject to valorization.

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31 **Key words:** Cumulative degree of perfection, renewability, exergy analysis, tea processing,
32 waste valorization

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