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INNOVATIVE DESIGN OF PACKAGING IN THE FOOD SECTOR TO REACH HIGHER SUSTAINABILITY

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ABSTRACT

The choice of a sustainable packaging alternative is a key issue for the improvement of the environmental performances of a product. The present study is focused on the life cycle assessment of two packaging alternatives of a poultry product; in particular a polystyrene-based tray and an aluminum bowl were considered. The aluminum bowl was carefully designed in order to allow its use during the cooking stage in oven and reducing of cooking time. The cooking stage resulted to be the most impacting one over the entire life cycle of the two alternatives considered (taking into account production, transports, cooking and end-of-life), so the specific design of the packaging bowl/tray can allow significant lowering of the overall impacts.

INTRODUCTION

Generally it is believed that a packaging with low impacts during its production and end-of-life (i.e. biopolymer and biodegradable polymers) is also the most sustainable one (Colwill et al., 2012). Packaging is usually seen as a container with no other function than just containing the product to be carried in it, so when this concept is applied to food packaging the choice of a packaging that best suites the requirements of fresh food is driven by issues such as cost, shelf life, safety, practicality and, in the last years, environmental sustainability (Meneses et al. 2012, Suwanmanee et al. 2012).

The aim of the present paper is to show that life cycle assessment (LCA) may be a useful tool in order to improve the environmental performances of a packaging system by the use of a material, such as aluminum, that allows for its direct use in the cooking stage, avoids the use of another container in oven and, if properly designed according to the food contained, it can allow for further savings during the cooking itself.

MATERIALS AND METHODS

In the present study life cycle assessment of two different packaging options was carried out. The perspective was "from cradle to grave", so both the use stage and end-of-life of the two options were considered.

Option 1: Aluminum bowl, 60 wt% primary and 40 wt% secondary aluminum. Weight: 23.5 g
This option will be defined as AL-P in the manuscript.

Option 2: Polystyrene bowl. Weight 13.15 g. This option will be defined as PS-P in the manuscript.

All the other components of the two packaging options, such as polyethylene labels, PVC films and glue, that are similar for the two alternatives, were included in the LCA also considering their transports, packaging and production.

Use stage: the aluminum bowl was carefully designed in order to allow its use during the cooking stage in oven of the poultry product and reduce the cooking time (40 minutes instead of 50 minutes needed when using a conventional bowl) at 200 °C: cooking time reduction allowed electric energy savings equal to 0.21 kWh (1.38 kWh instead of 1.59 kWh). The only energy source considered is grid electricity, so the Italian energy mix was used and the consequent emissions accounted for when calculating the GHG (GreenHouse Gases) emissions. It was assumed that the Italian energy mix accounts for 0.605 kg CO₂-eq for each kWh (Ecoinvent, 2010)

End-of-life: this stage is dominated by recycling of trays materials. In this paper the approach suggested by (PAS 2050 : 2011), defined as “recycled content” was used. End-of-life was modeled taking into account Italian waste management and statistics for aluminum and plastic wastes.

Two different methods were used for Life Cycle Impact Assessment (LCIA):

- Greenhouse Gas Protocol (GGP): allows the calculation of the total GHG emissions for a product inventory are calculated as the sum of GHG emissions, in CO₂eq, of all foreground processes and significant background processes within the system boundary
- Recipe Endpoint H: it is a multicategory method whose results are calculated according to endpoint perspective.

RESULTS AND DISCUSSION

GGP results are reported in table 1

Tab 1 – GGP, excluding use phase and end-of-life

Category	Unit	AL-P	PS-P
Total	kg CO ₂ eq	0.343	0.131
Fossil CO₂ eq	kg CO ₂ eq	0.369	0.161
Biogenic CO₂ eq	kg CO ₂ eq	0.060	0.052
CO₂ eq from land transformation	kg CO ₂ eq	0.000	0.000
CO₂ uptake	kg CO ₂ eq	-0.085	-0.082

The AL-P alternative resulted less sustainable than PS-P when excluding the cooking stage and end-of-life. The difference, expressed as kg CO₂ eq, between AL-P and PS-P was equal to

0.212 kg CO₂ eq. When the LCA perspective included also use and end-of-life stage, results obtained are the ones reported in table 2.

Tab 2 – GGP, including use phase and end-of-life.

Category	Unit	AL-P	PS-P
Total	kg CO ₂ eq	1.18	1.07
Fossil CO₂ eq	kg CO ₂ eq	1.20	1.11
Biogenic CO₂ eq	kg CO ₂ eq	0.07	0.07
CO₂ eq from land transformation	kg CO ₂ eq	0.00	0.00
CO₂ uptake	kg CO ₂ eq	-0.09	-0.10

From data reported in table 1 and 2, AL-P resulted less sustainable than PS-P. However its specific design allowed for lower impacts during the cooking stage, so that the difference between AL-P and PS-P, when the whole life cycle was considered, was reduced to 0.110 kg CO₂eq.

It is argued that the assessment of the life cycle of a product by using only CO₂eq quantification may have some limitations (Laurent et al. 2012): indeed results obtained with a second method taking into account different impact categories, such as Recipe H Endpoint (including use phase and end-of-life), showed that impacts of the two trays, according to GGP, are higher for PS-P. However, when considering the whole life cycle (fig.1) AL-P option was more sustainable, due to its lower impacts during the cooking stage.

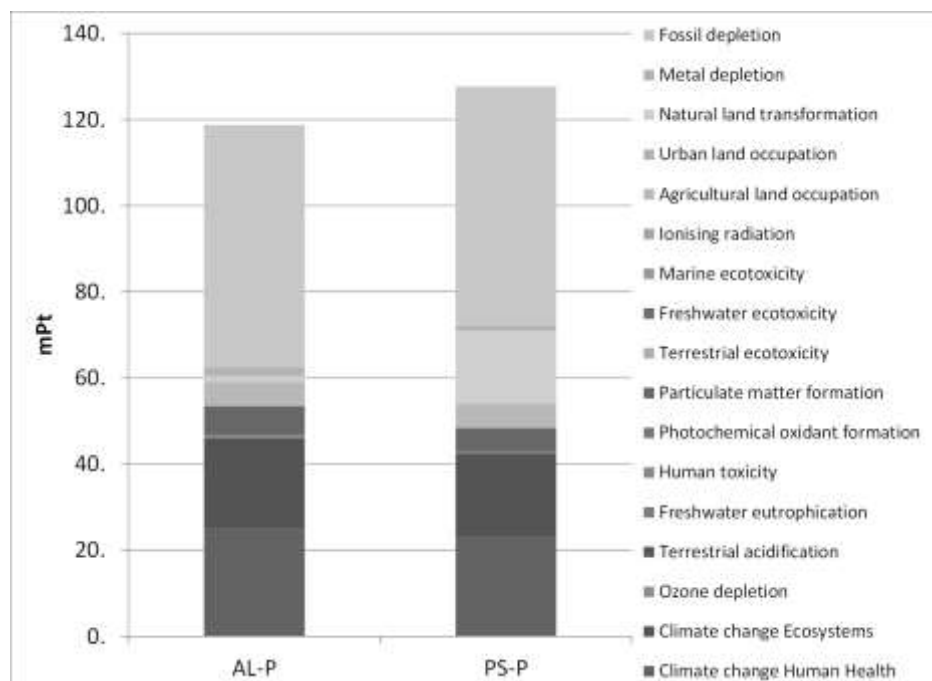


Fig. 1 – Recipe H Endpoint, from cradle-to-gate perspective



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CONCLUSIONS

LCA from “cradle-to-gate”, excluding use phase and end-of-life, showed that PS-P tray is more sustainable than the aluminum one; nevertheless the AL-P tray was specifically designed to allow for energy savings during the cooking stage of the poultry product contained in the tray. The cooking stage resulted to be the most impacting one over the entire life cycle of the two alternatives (taking into account production, transports, cooking and end-of-life), so the specific design of the tray itself allowed significant lowering of the overall emissions according to Recipe Endpoint H and GGP methods. When considering Recipe Endpoint H AL-P resulted more sustainable than PS-P

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