



**Hochschule
Albstadt-Sigmaringen**
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PLA-fiber composite packaging for fresh produce

PLA2Scale project (Förderkennzeichen: 2221NR033B) in cooperation with IfBB Institute of Bioplastics and Biocomposites of the Hochschule Hannover University of Applied Sciences and Arts.

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Gefördert durch:



aufgrund eines Beschlusses
des Deutschen Bundestages

The SPI in Sigmaringen



Forschungsfabrik
Startup - Zentrum
Akademie

- The Sustainable Packaging Institute (SPI) teaches & researches in six thematic areas



- The institute has a research focus on „**sustainable packaging concepts**”

PLA-fiber composite - objective



The **overarching goal** is to expand the application possibilities of PLA to increase market share, thereby making recycling economically attractive.

Project **objective** was to integrate fibers into a PLA matrix to obtain
→ A bio-based and circular packaging to extend the **field of application** of PLA
→ A more **economically** interesting packaging

Fresh produce (fruits & vegetables) need **intensive gas exchange** through packaging

Figure 1. Schematic presentation of the objective of PLA-fiber composite systems for fresh produce within the PLA2Scale project

PLA-fiber composite – requirements and preliminary tests

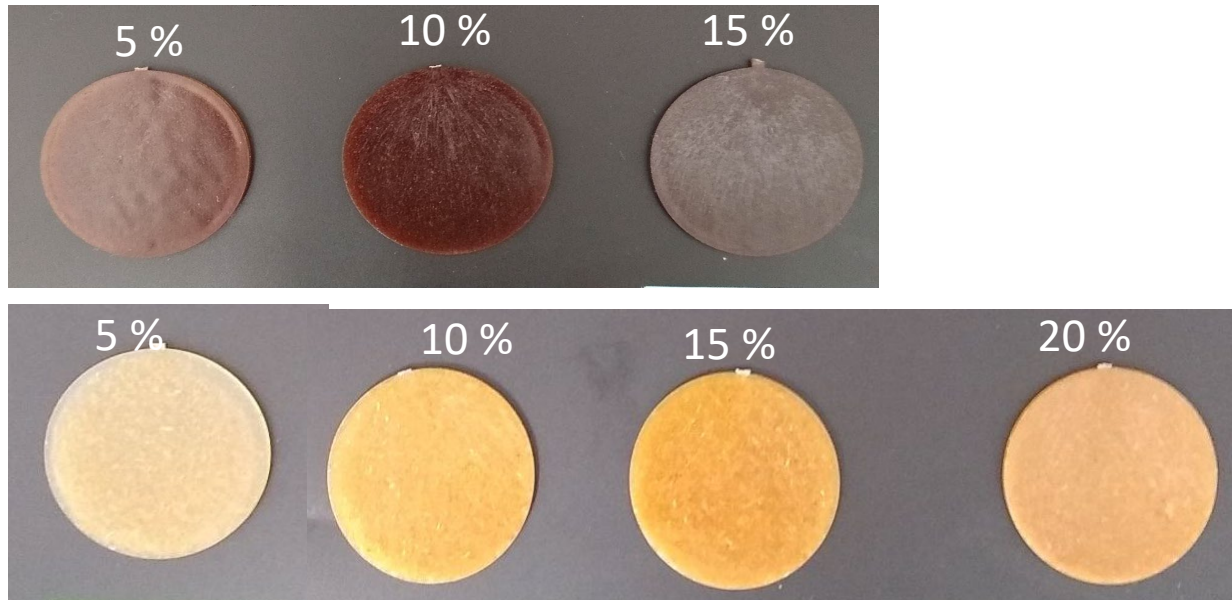


Figure 2. Injection molded PLA-apple fiber (upper row) and PLA-wood fiber specimen with varying fiber concentration (own images, SPI)

Fresh produce packaging **requirements:**
OTR > 10.000 cm³/m²·d·bar and WVTR > 10 g/m² d

Preliminary tests by varying fiber type and concentration, plasticizer type and concentration, film thickness, take-off speed of the compounder with flat film system

Results show PLA-fiber composite films obtain OTR range (23°C, 50% r. h.) between: ~2,000 and 255,300 cm³/m² d bar (over measuring limit)

PLA-fiber composite - film thickness



Figure 3. Microscopy images of microtome sections: 85% PLA, 10% wood fibers, and 5% plasticizer (left); 80% PLA, 10% apple fiber, and 10% plasticizer (right)

PLA-fiber composite – film production semi-industrial scale

PLA-wood fiber film



PLA-apple fiber film

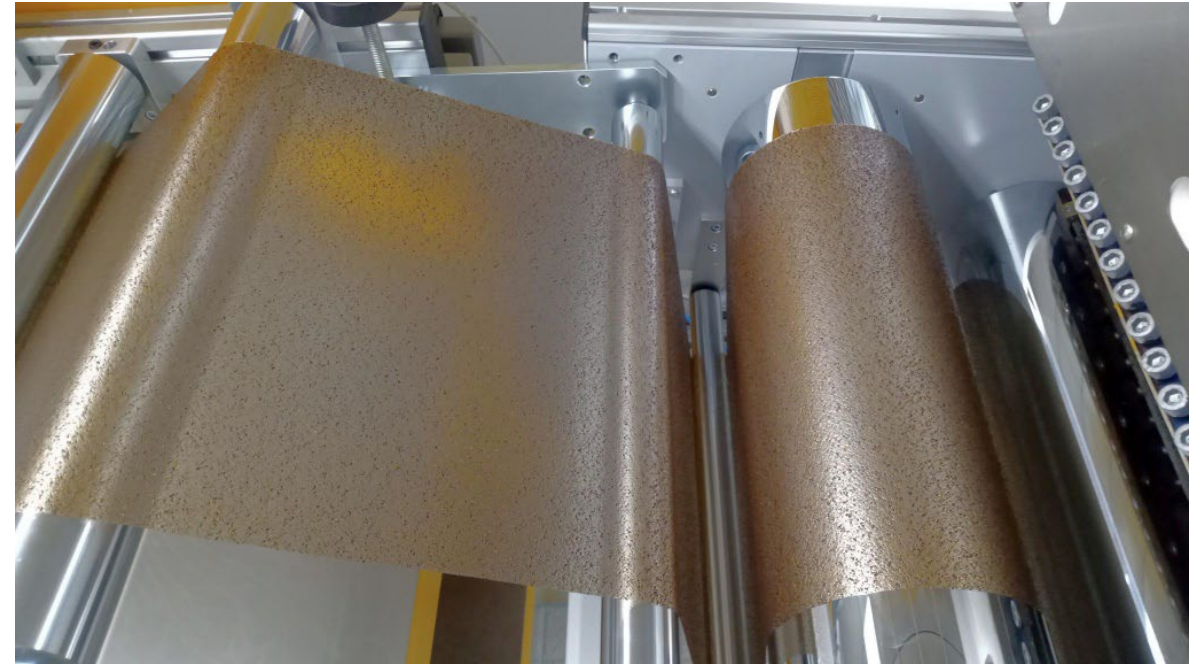


Figure 4. Compounder with flat film system – production of PLA-wood fiber films (left image) or PLA-apple fiber film (right image) (Sustainable packaging institute, own source)

PLA-fiber composite – packaging functionality?

Packaging and storage trials

Food: Blueberries

Developed packaging: thermoformed trays: PLA; PLA-apple fiber (10%); PLA-wood fiber (10%)

Lid film: PLA (10% plasticizer) ~50 μm film thickness

Reference packaging: perforated PET (tray and lid)

Storage test: 25 days (4°C)

Testing: headspace gas composition, sensory evaluation, weight loss



Figure 5. Packaging of blueberries into developed PLA-apple fiber tray (Slice-Pack-Line, Bizerba) (own illustration, SPI)

PLA-fiber composite – packaging functionality?

Reference system:

Petrochemical market available packaging with holes (~4.8 cm² perforation area)



Developed systems:

PLA



PLA-wood fiber (10%)

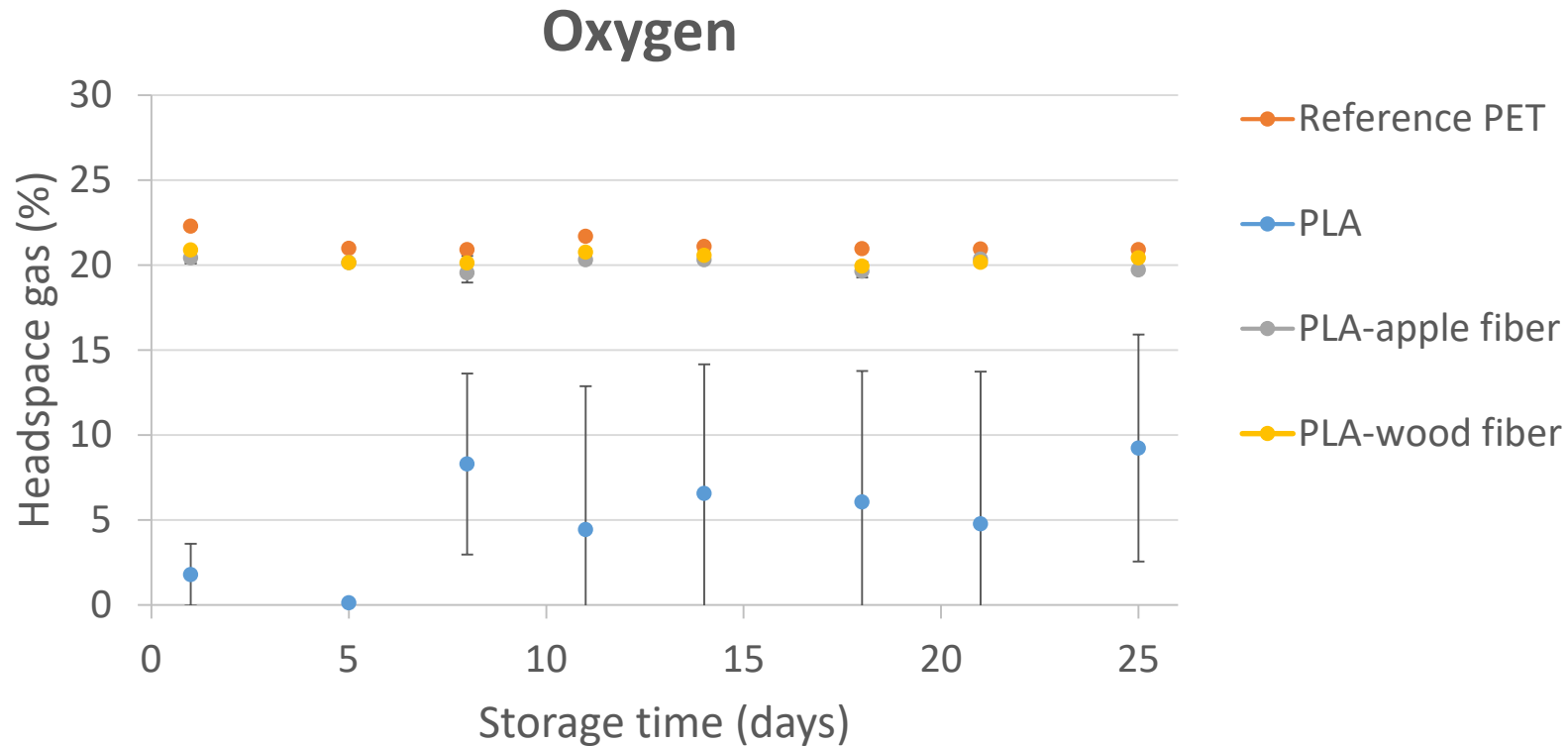


PLA-apple fiber (10%)



Figure 6. Packaging systems used for packaging and storage trials of blueberries (own source, SPI)

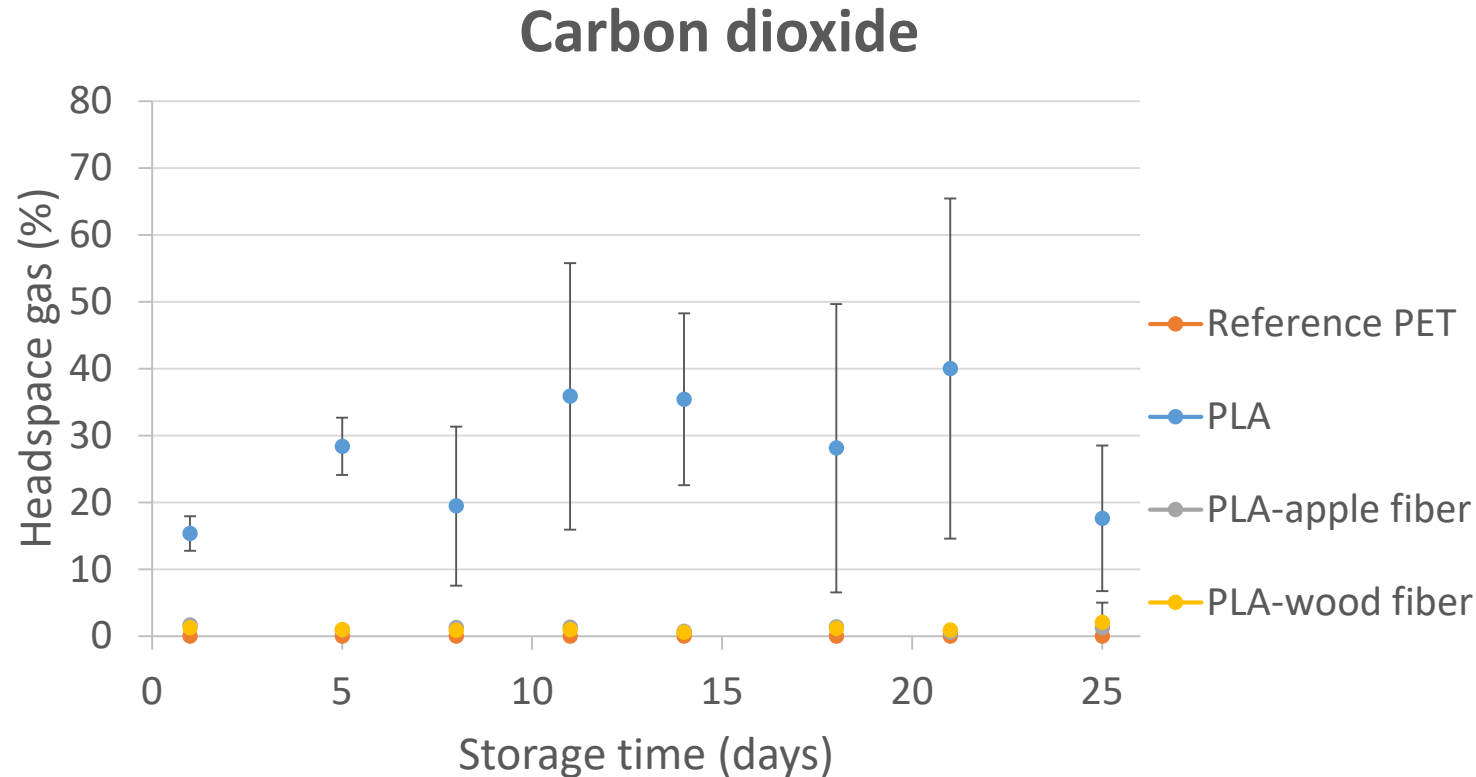
PLA-fiber composite – packaging functionality – Storage testing oxygen in headspace



→ Fibers lead to **very thin diffusion pathways** in the PLA matrix which increases oxygen exchange

Figure 7. Headspace gas composition – Oxygen in packaging containing blueberries in reference PET tray, PLA tray, PLA-wood fiber (10%) tray or PLA-apple fiber (10%) tray

PLA-fiber composite – packaging functionality – Storage testing carbon dioxide in headspace



- Fibers lead to **very thin diffusion pathways** in the PLA matrix which **increases carbon dioxide exchange** to a high extent
- Carbon dioxide accumulation in PLA trays
- Trend of extended shelf life in PLA-fiber trays

Figure 8. Headspace gas composition – Carbon dioxide in packaging containing blueberries in reference PET tray, PLA tray, PLA-wood fiber (10%) tray or PLA-apple fiber (10%) tray

Concluding remarks

PLA as a sustainable basis: bio-based, (industrially) biodegradable, commercially available, already well-researched polymer,...

PLA-fiber:

- Integration of side stream products up to 15% approved
- Film production in semi-industrial scale approved
- Applicability for fresh produce (new field of application)

Potentially leading to a reduction in price and increasing PLA stream on the market
→ economically more interesting for sorting and recycling of PLA



Shaping a sustainable future together

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<https://www.hs-albsig.de/forschung/iaf/fachinstitute/sustainable-packaging-institute-spi>