PULSE CANADA

CASE STUDY

PEA STARCH IN THE PAPER MAKING PROCESS

Case Study:
Pea Starch in the Paper Making Process

This study served to evaluate the potential of incorporating pea starch at various stages of the paper making process. Two types of starch-rich material were used to determine their function for ply cohesion, size-press and adhesive applications.

WHAT IS PEA STARCH?

Pea starch is a co-product derived in the production of protein. It is characterized by high amylose concentrations, conferring greater resistance to high temperature processing, higher final viscosities after cooking, and stronger gelling abilities compared to common commercial starches.

There are two types of starch-rich material that can be produced from peas:

1. **Starch-Rich Flour (60-85% starch):** produced from pea flour using a process known as air-classification, separating starch and protein particles based on differences in their size and density.
2. **Pea Starch Isolate (>85% starch):** produced from pea flour using a wet extraction process, separating starch and protein particles based on differences in their size and solubility.

PEA SEED COMPOSITION

Protein (%db)	Starch (%db)	Amylose (%starch)
18-28%	30-45%	30-50%

Results

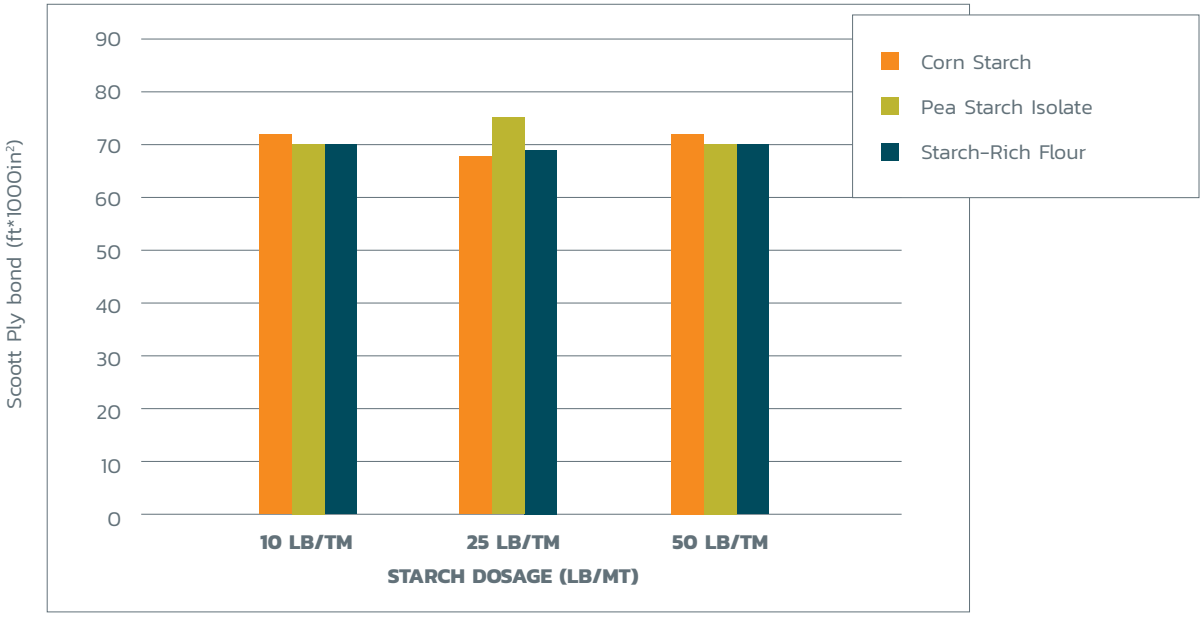
PLY COHESION APPLICATIONS

Multi-ply dynamic laboratory handsheets were prepared using three starch dosages of 10, 25 and 50 lb/MT. Samples were pressed between press felt and Teflon sheet at 60 psi then dried for 10 minutes at 221°F. Physical property testing was conducted to determine the strength of the resulting paper.

Scott Plybond

Scott Plybond testing determines the strength of paper during which a pendulum strikes an angle bar taped to the paper sample, resulting in a similar motion to peeling. The energy absorbed by the paper is indicative of the internal bond strength. The performance of both pea starch isolate and starch-rich flour was equivalent to corn starch. A starch dosage effect was not observed, indicating that a low dosage of pea starch (10 lb/MT) is sufficient for ply cohesion applications.

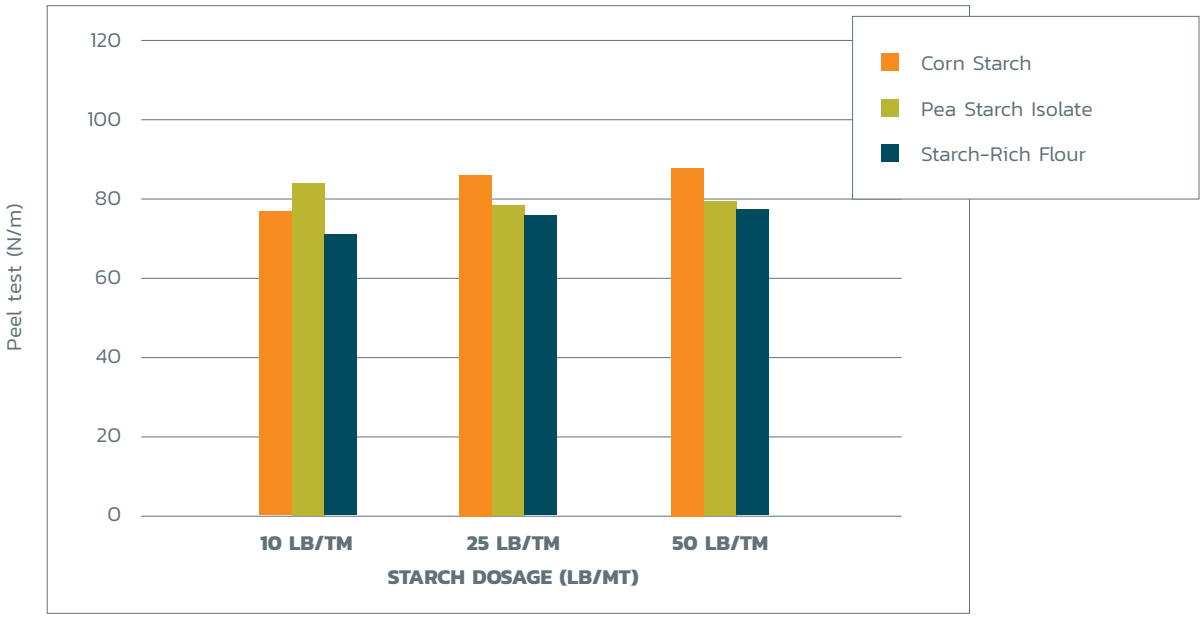
SCOTT PLYBOND ON MULTI-PLY DYNAMIC HANDSHEETS, FROM INNOFIBRE AT 10, 25 AND 50 LB/MT



Peel Test

Peel testing determines the tensile strength of paper. In this test, the paper sample is pulled away from its position while securly taped to a free-turning wheel, resulting in a similar motion to tearing. Results of the peel test confirmed those of the Scott Plybond test. A starch dosage effect was also not observed in this test, again indicating that a low dosage of pea starch (10 lb/MT) is sufficient.

PEEL-TEST TO MULTI-PLY DYNAMIC LABORATORY HANDSHEETS



Multi-ply handsheets produced from both pea starch isolate and starch-rich flour had similar tensile strength to handsheets prepared from corn starch.

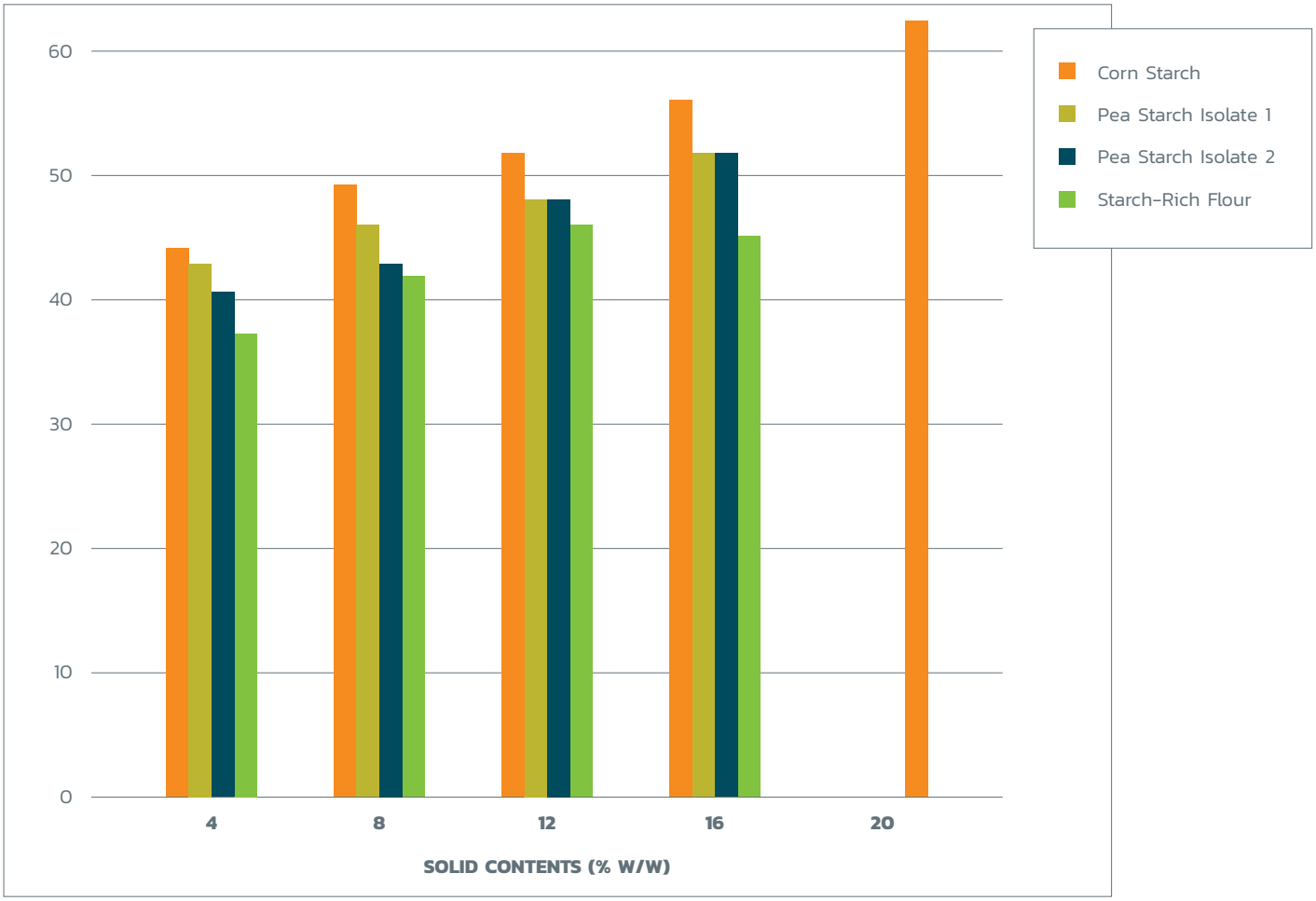
SIZE-PRESS APPLICATIONS

Pea and corn starch samples were cooked and hydrolyzed at a solids content of 4–20% (w/w) for application on paperboard using a laboratory size press. Samples were evaluated to determine their compression strength, stiffness and bursting strength.

- Overall, the application of pea starch isolate in concentrations less than 16% (w/w) resulted in similar mechanical properties as compared to corn starch samples.
- Starch-rich pea flour also displayed acceptable performance at solids contents of 12% (w/w) or less. At higher solids concentrations, the presence of other pea seed constituents such as protein or fibre could contribute to its instability in this application.
- The retrogradation rate of both pea starch samples at 20% solids content was too substantial and could not be applied on the paper.
- These results warrant further investigation of pea starch isolate in large-scale size-press operations.

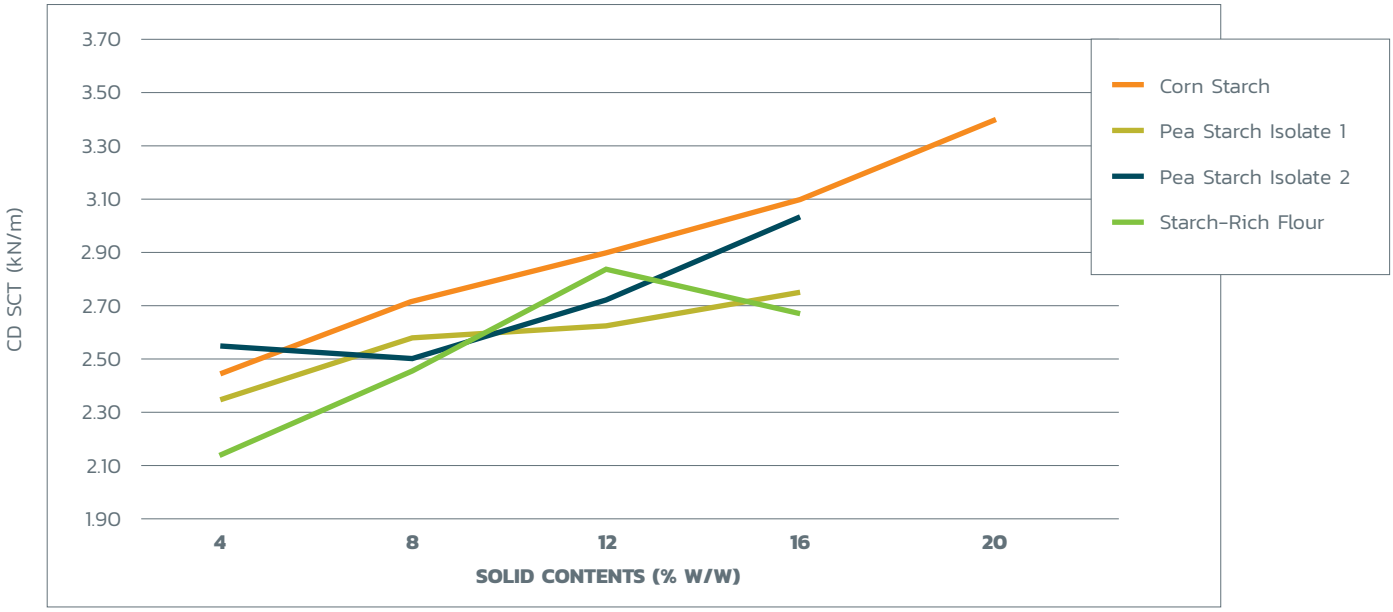
RING CRUSH

Ring crush test measures the strength of paper during which the paper is shaped into a standard ring and compressed between two plates at a speed of 12.5mm/min until collapse. CD RCT = Cross direction ring crush test.



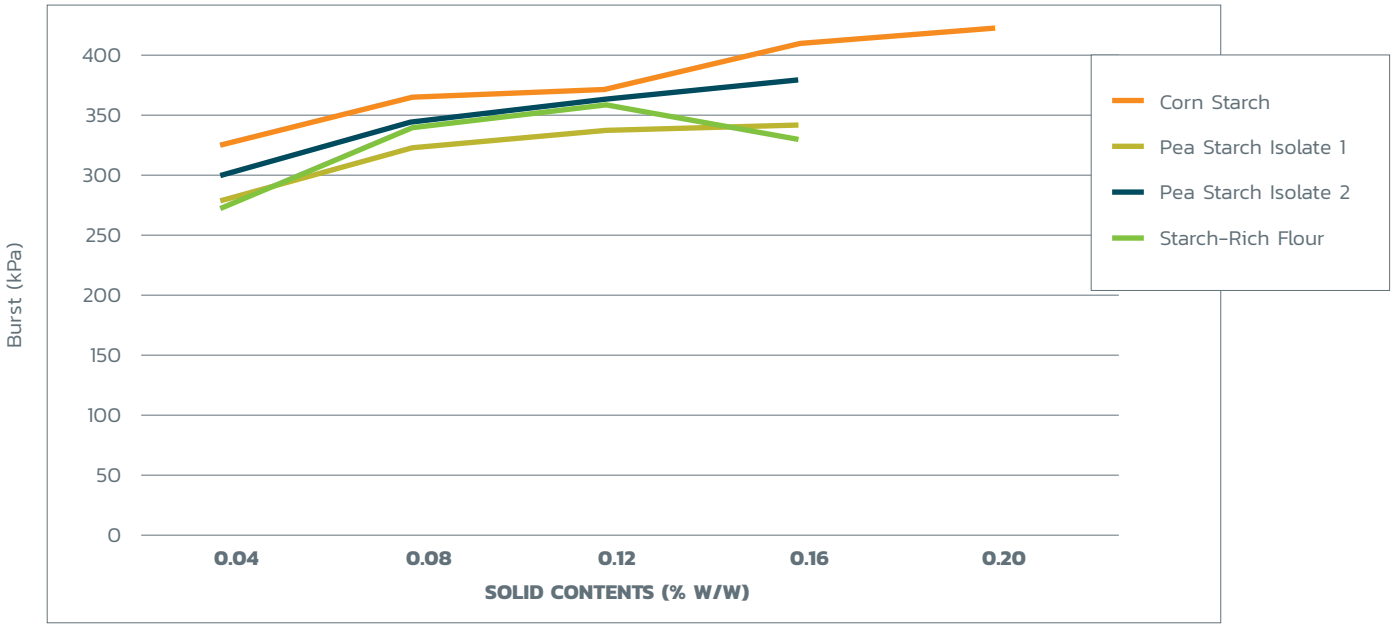
STFI COMPRESSIVE TEST

STFI test is another measurement of compression strength, during which a strip of paper is clamped and compressed inwards from the bottom and top of the paper. STFI = short-span compression test, CD SCT = cross direction short-span compression test.



BURST STRENGTH TEST

Burst test evaluates the strength of paper during which the sample is clamped between two plates and a digital hydraulic board evaluates the minimum amount of pressure required to rupture the sample.



CORRUGATOR ADHESIVE

Starch samples were used to formulate an adhesive glue line on corrugated paperboard samples.

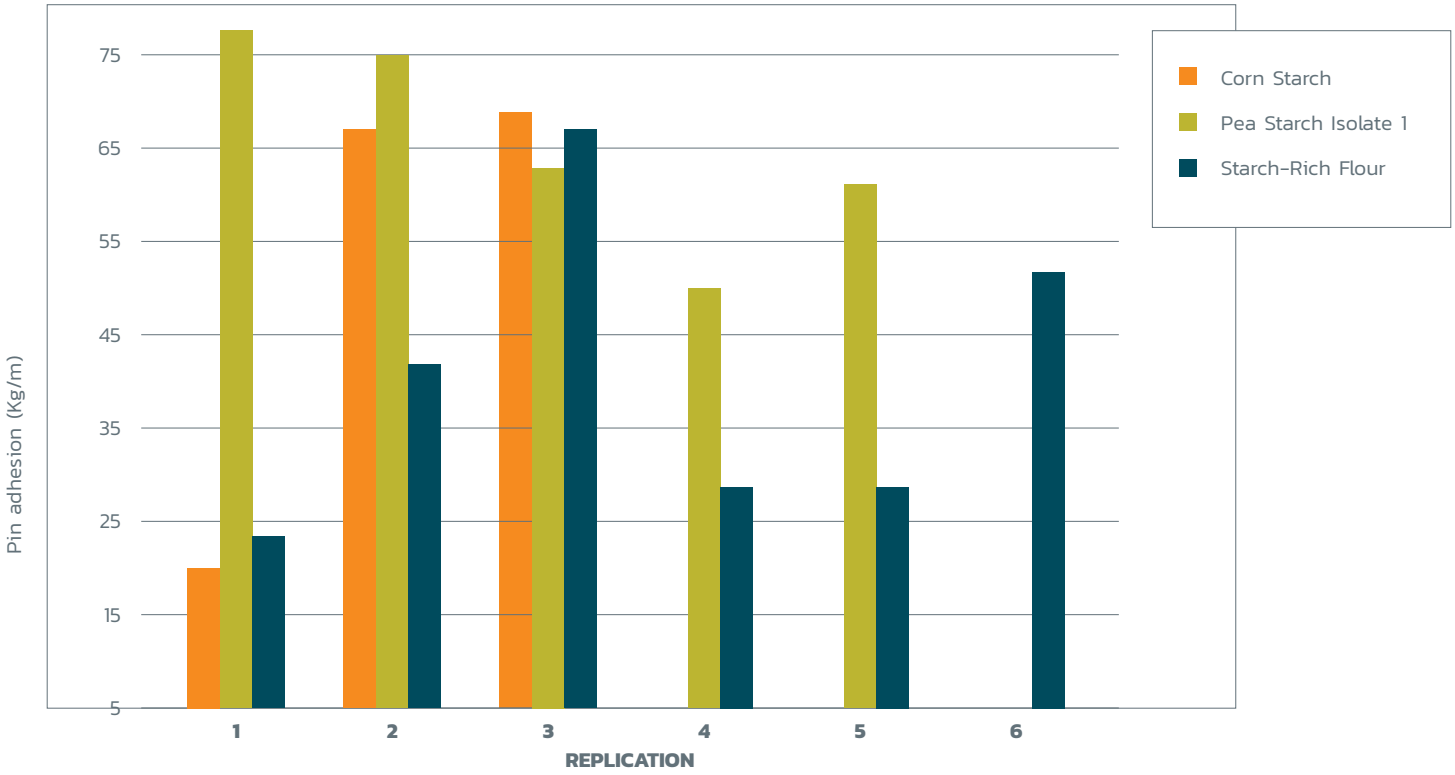
Pea starch isolate shows stable and similar performance to corn starch, where the addition of a waterproof resin in adhesive formulations contributed to over 24-hour water-resistance. Pea starch isolate produced an adhesive with a 3 degree C lower gelatinization temperature, which should result in lower energy consumption, and higher speeds in gluing machines. This indicates that adhesives made from pea starch should develop tack at lower temperatures, and set up faster, allowing gluing machines to run quicker than when using corn starch.

Adhesives made with starch-rich pea flour were unstable as a result of different textural properties and unable to form a water-resistant bond.

Based on the results, larger-scale trials of pea starch isolate as a corrugator adhesive are recommended.

PIN ADHESION OF CORRUGATED SHEETS

Pin adhesion determines the strength of the adhesive on a corrugated board during which flutes are used to measure the force required to separate the liner board from the medium.

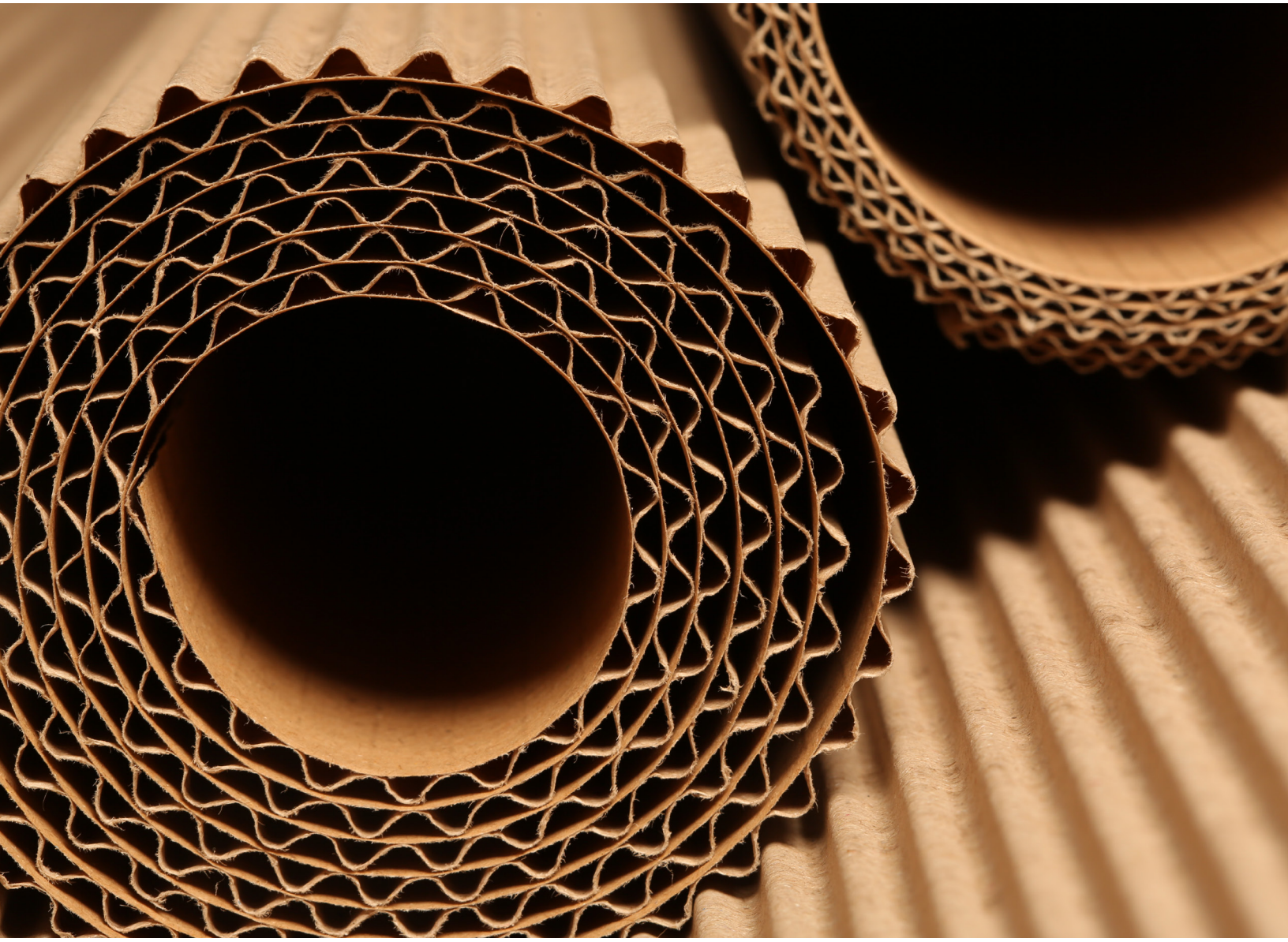


PHYSICAL PROPERTIES OF ADHESIVE FORMULATIONS

Protein (%db)	Water Resistance (h)	Gel Point (°C)	Harper LoveCup Viscosity (Sec)
Corn Starch	>24 h	64	24
Pea Starch Isolate	>24 h	61	24
Starch-Rich Pea Flour	< 1h	69	25

Highlights

- Pea starch isolate is a good candidate for all three paper applications evaluated (ply cohesion, size-press and corrugator adhesive).
- Starch-rich pea flour could be used in ply cohesion, however it may not be suitable for size press applications. Further studies evaluating the adhesive formulation could determine its suitability as a corrugator adhesive for non-water-resistant applications.



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