MARKET ORIENTATION IN BIOREFINERY RESEARCH

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Wood K plus?



Basic research \longrightarrow Prior to the research \longrightarrow Industrial Development 2

<u>K</u> plus

Why Market Orientation?

Because funding agencies want it? Market assessment is to accompany the technical research at the applied research stage – NEVER before – SELDOM beyond!!

It should guide the development:

- towards <u>optimized value</u> creation (e.g. what properties increase value or volume at most?)
- to <u>avoid wrong</u> developments (e.g. what are standards/needs?)
- by <u>projecting dimensions</u> for up-scaling (e.g. this amount is demanded at that price)
- to <u>ease market entry barriers</u> (e.g. selling in this application field demands partnerships)



What Market?



Bio-refining is a multi step/firm business: Integrated assessments are essential!!!



Potentials of Kraft-Pulping in Europe

Product	Formed / currently exploited (tn/year)	Current applications	Potential applications
Pulp	28,000,000/ 28,000,000	Paper, packaging	A BILLIONSI
Lignin	14,000,000/ <5,000	Fuel, chemicals	bo-oibiesins, <u>adhesives</u> , lubricants, discussants, absorbents, insulative materials, soulyst supports, antioxidant, <u>carbon fibres</u> , composites
Hydroxy acids	7,500,000/ 0	None no no nitali	Complexing agents, descaling agents, detergents, building blocks for sugar derivatives and biopolymers, food ingredients (mild acid orste, sugar confectionary)
Hemicellulose: Xylan or glucomannan		Note the pill	Papermaking aids, wet-end additives, hydrogels, <u>food/cosmetic additives</u> , pharmaceuticals, barrier coating films, starting chemicals after hydrolysis for sugar platform chemicals – <u>Ethanol</u>
Formic + acetic acid	3,500,000	NEGO	Bulk chemicals with low added value
Extractives	1,500,000 000	Tall oil (fatty acids, resin acids, sterols), turpentine	Antioxidants, dietary supplements, <u>cosmetics,</u> <u>pharmaceuticals</u>
afore			Wood K plus

Potentials of Kraft-Pulping in Europe

Product	Formed / currently exploited (tn/ year)	Potential substitute	Value per unit (based on COMTRADE EU27 – export values 2009)	Potential production/sales value (based on COMTRADE)
Pulp	28,000,000/ 28,000,000		100% (Base)	100% (Base)
Lignin	14,000,000/ <5,000	Phenolic chemicals	300%	36.6%
Hydroxy acids	7,500,000/ 0	Phosphatic compounds	278%	43.9%
Hemicellulose: Xylan or glucomannan	2,000,000/ 0	Starch/Inulin Gum Arabic	128% 788%	9.0% 1.96%
Extractives	1,500,000/ 500,000	Essential Oils Polyphenols Tannine	5858% 1141% 933%	0.04% 0.87% 0.55%
				≈ 90% TOTAL





Hemicelluloses as an Intermediate

Comparable plant polysaccharides are abundant in the food and other industries –

But again niche versus commodity applications!

Commodities

Starch and Sugar: Brazil exports 24 million tons of raw sugar a year, Price about 600 USD/t

Specialities

Gum Arabic: Nigeria and Sudan export about 60.000 tons a year, Price about 3.500 USD/t





Value of Hemicelluloses?







Don't stop thinking at intermediates!





Product Upgrading - Commodities

Once competitive at the substitute's cost level way is open for upgrading, for example:

• Lignin in wood based panels

(market entry barriers/avoid misdevelopments)

- Hemicelluloses based films in food packaging applications (optimize value/dimensioning)
- Complexing agents

(market entry barriers/dimensioning)

...





Methodological Framework for Market Orientation in Biorefinery Development





Hemicelluloses based films in food packaging

Selected properties of hemicellulose films

medium tensile strength (~50MPa) Stiffness similar to LDPE low oxygen permeability (OP) high water vapour permeability (WVP) High aroma barrier No sealing capabilities limited shelf life(6 months) Dyable and und printable



B2B-survey covering 26 companies in the packaging business

•Total Sales Volume: 786,751 t/a

•since 2009 rise of raw material prices (PE: 1400€/t)

•~3%/a market growth (meat and sausages, convenience food)





Source: Mikkonen, 2009

The Model

Example: Market potential of hemicellulose film EB-50

Film properties

OP (cm³·µm/m²·24h.kPa)	0.3
WVP(g/m²·24h)	2
Sealable	no
Shelf life(months)	6

Degree of fulfillment

Nr.	Product group	OP (%)	WVP (%)	sealable (%)	Shelf life (months)	MP (%)	Sales volume(t)
1	Meat and sausages	100.00	2.50	3.75	100.00	0.094	82.38
2	Cheese and dairy products	57.78	34.44	1.11	100.00	0.221	277.51
3	Bakery products	82.50	14.00	8.00	0.00	0.000	0.00
4	Pasta and dry foods	82.50	0.00	0.00	0.00	0.000	0.00
5	Vegetables and fruits	0.00	88.00	0.00	100.00	0.000	0.00
6	Confectionery	100.00	0.00	15.00	0.00	0.000	0.00
7	Convenience food	100.00	2.20	18.00	100.00	0.396	567.33
8	beverages	k. A.	k. A.	0.00	0.00	0.000	0.00
Total market potential (n=26)				0.118	927.23		





Future Market Potential

Future market potential of hemicellulose-film EB-50 based on the 26 companies can be improved by developing:

Sealable → 30,300t/a

- cheese, meat and sausages, convenience food
- no pasta und dry foods, confectionery, beverages (low WVP, shelf life) special case: vegetables and fruits: perforation

low WVP → 29,000t/a

- cheese, meat and sausages, convenience food
- Problem: not sealable, shelf life

Shelf life 24 months \rightarrow 1,335t/a

supplementary bakery products

Sealable and low WVP → 273,000t/a

- Still no pasta and dry foods, vegetables and fruits





Outlook

There is a great potential to support technical research and development by market assessment models.

The **simplistic modelling** approaches basically allow to:

- Identify the most valuable product properties
- Define product standards to be meet
- Asses dimensions for up-scaling or industrial investments





Another story: Lignin in Wood based Panels

Technical research to partially substitute phenolic resin with kraft lignin since ~30 years. Still the substitution has not reached the expected market share –WHY????

Expert survey – multistage Delphi-based approach.

Why did technical lignin not succeed so far in substituting phenolic resins in the wood based panel industry?





Barriers and incentives for kraft lignin utilisation

12 experts (4 different backgrounds) were asked about barriers and incentives for substitution of phenolic resins

10 factors have been identified

	Factor name	Description	Factor type	Nature
1	Raw material	Problem variation in lignin structure and guality	Barrier	KO*
2	Energy	Lignin needed as energy source by the pulping industry	Barrier	KO
3	Technical properties	Declining technical properties of produced panels	Barrier	Variable
4	Productivity	Increasing production time	Barrier	Variable
5	Security of supply	Difficult to assure	Barrier	Variable
6	Economic feasibility	Depending on crude oil price and lignin demand	Barrier	KO
7	Use of phenolic resin	Is decreasing, hence future demand uncertain	Barrier	KO
8	Marketing	e.g. eco-labelling could be applied	Incentive	Variable
9	Price difference	Lignin is cheaper than glue	Incentive	Variable
10	Renewable resource	Lignin as renewable resource is a long term strategic supply option	Incentive	KO

*KO: knockout.





Rating of variable factors









How to resolve barriers:

- →Research and development
- \rightarrow Build up trust with panel industry
- → Strengthening of cooperation between pulp & chemical & panel industry





Product Upgrading - Specialities

Examples:

- Essential oils as flavours and fragrances
- Dietary fibre food additives (XOS) from Xylan
- Phytosterols from Tall oil as cholesterol level lowering agents
- Terpenes and lignans could be used as <u>BIOACTIVE</u> <u>SUBSTANCES</u> in dietary supplements, functional foods, cosmetics, pharmaceuticals as antioxidants, active agents against osteoporosis, positive cardiovascular effects and a weight loss effect.

Need to be competitive at the substitute's quality/effectiveness level hence upgrading requires more detailed market assessments.





Methodological Framework





Competing Products

There are already natural products in these applications...

Grape Tea Herbs

... Pine!!!







Requirements????







What are companies (n=56) willing to pay?







What are companies (n=56) willing to pay?







Well – but this is small market...

What will happen if new capacities enter that market?



26

K plus



OK - so we can start to produce ...

Slowly – you may need to consider consumer accaptance...

Why eat wood?

Consumers were willing to pay more for polyphenols for food additives from forest based bio-refinery as long as they did not have an idea that a lot of food additives are already made from natural raw materials.

Stories will be needed – ideally based on quality...

- better effectiveness
- better sustainability
- how interesting these trees are





Outlook







Thank You!

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Vom Co- zum By-Product (Söderholm & Lundmark, 2009)

Die Frage trifft die Bioraffinerie sowohl beim Rohstoff (SNP), als auch beim Produkt (z.B. Joint Costs).



Angebotselastizität – Produktionskosten - Joint Costs

