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WORLD BREWING CONGRESS 2016

Pectin and gallotannin/ pectin combination as alternative fining agents to reduce maturation time and improve filtration performance

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World Brewing Congress
August 13-17, 2016
Sheraton Downtown Denver
Denver, CO 80202, U.S.A.

INTRODUCTION

Fining agents are used to improve the filtration performance and to reduce the production time of clear and bright beers. Conventional agents that are being used within the beverage industry like Isinglass or gelatin are derived from animals, whereas pectin and gallotannin are mentioned in literature as possible non-allergenic, vegetarian alternative fining agents [3]. Based on earlier studies [1, 2, 3] the aim of this investigation was to compare the influences of different pectin and gallotannin/ pectin applications during the maturation process to figure out the best procedure to reduce maturation time and improve filtration performances. In these kind of investigations the used pectin and gallotannin types as well as their concentration and dosage sequence after main fermentation were of particular importance.

TEST METHODS

- **Standard beer analyses according to MEBAK[4]:** Turbidity (2.14.2.1) color (2.12.2), pH-value (2.13), apparent and real extract (2.9.6.3), bitter units (2.17.1)
- **Used pectin type:** The used pectin designated as "pectin A" has been proven in pre-trials as most applicable in the used beer matrix [3]. 1 or 0,5 g pectin were dissolved in 100 mL dist. water (75°C) [5]. (*Lab at TU Berlin, Chair of Brewing Science.)*
- **Lab-Filtration-Tests:** The pectin-quick-test [1,2] was made with 10, 20, 30, 40 and 50 ppm pectin dosage and a final measurement of the turbidity. For the filtration test 100 mL assay were filtered using a fluted filter (Grade 597 ½). The filtered volume was monitored after 5 and 7 minutes.
- **Sedimentation-test (on laboratory scale):** Cylinder flasks were filled with 250 mL unfiltered beer and treated with different pectin and gallotannin (Brewtan C & F) dosages. The supernatant's were analysed after 24 h.
- **Sedimentation- and filtration-trials:** *(TU Berlin, Research Brewery)* Cylindrical conical fermentation tanks (50 L) were filled with beer after fermentation (hose beer) and treated with different pectin, gallotannin and pectin/ gallotannin dosages during beer transfer. The sedimentations were conducted for 3 days maturation time at 0°C. After separating the flock, the resulting beers were filtrated using the pilot FIILTROX pre-coat filtration plant with kieselguhr.

Fig.1: : Filtrox Synox 100 PF filtration pilot plant at TU Berlin

RESULTS

After pre-selection of most suitable pectin types in previous studies [1, 2] additional centrifugation quick-tests were carried out to figure out the best pectin dosage.

The results in fig. 2 demonstrate that the turbidity sags significantly with an increasing pectin dosage up to a certain reversal point wherefrom a higher pectin dosage leads to a slightly increasing turbidity, which in logical order can have a disadvantageous effect on filtration. The range near to the reversal point describes the optimal pectin dosage with best fining effects. To get a deeper insight into possible negative effects caused by overdosed pectin a filtration test was carried out with the supernantant of additional settling tests. Results in fig. 3 show the volumes of the filtrates after 5 and 7 minutes.

It is obvious, that the filtration speed can be improved by the pectin application up to an optimum and reversal point with 15-25 ppm. In correlation to the slight increase of the turbidity using the centrifuge quick-test a higher pectin dosage causes a decrease in filtration performance.

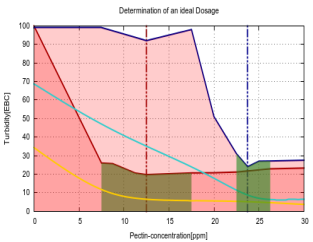


Fig.2: Correlation between pectin efficiency and its dosage. Green: optimal area; Dashed: ideal concentrations.

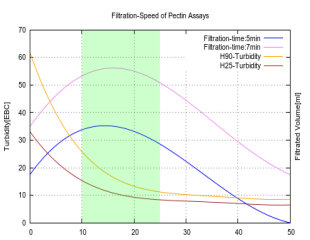
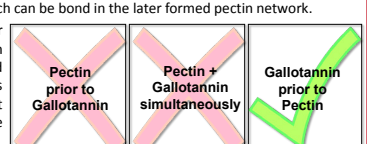


Fig. 3: Filtration speed in dependence of the pectin dosage

Against this background the combined application of gallotannin and pectin can be a useful tool to enhance the fining agent efficiency for specific beer matrices. For this kind of application the different reaction rates of used fining agents and the functional principle to enhance the clarification efficiency has to be under consideration, which give just one right sequence for the fining agent dosage. Gallotannin has to be added shortly prior pectin to generate very small gallotannin-protein haze particles which can be bond in the later formed pectin network.

A pectin dosage before or together with gallotannin can´t cause an enhanced clarification process because of the fast reaction rate for the pectin network formation.



RESULTS

The results of lab settling tests demonstrate the typical acceleration of sedimentation processes caused by the combined gallotannin/pectin application (fig. 4-5). The accelerated sedimentation may but is not necessarily combined with a better clarification, so that the only pectin application show a slightly better clarification after a longer settling time. In direct comparison of the used gallotannin products is the general better eligibility of Brewtan F obvious. The results in fig 6-8 demonstrate the floc formation and sedimentation of clarification trials at the TUB research brewery.

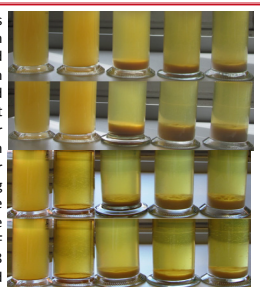


Fig. 4 & 5: Settling test: clarification effect after 1h / 24h resp. Front row: reference beer, Pectin, Brewtan C, Brewtan C + Pectin A-1, Brewtan C + Pectin A-2 Second row: reference beer, Pectin, Brewtan F, Brewtan F + Pectin A-1, Brewtan F + Pectin A-2

sample	haze, 90° [EBC]	haze, 25° [EBC]
Reference Beer	100.0	87.2
Reference Brewtan C	13.6	8.9
Reference Brewtan F	7,1	4,7
Reference Pectin A	2.4	2.9
Brewtan C + Pectin A-1	5.5	3.8
Brewtan C + Pectin A-2	7.7	5.2
Brewtan F + Pectin A-1	3.9	3.0
Brewtan F + Pectin A-2	3.6	2.8

The applied pectin- or gallotannin/ pectin-solutions directly cause a precipitation by adsorption and chemical bonding with haze particles and haze active protein fractions. In contrast to the reference the generated pectin or gallotannin/pectin floc shows a first obviously sedimentation direct after 1 hour with a clearly higher floc-volume in the case of gallotannin/pectin application. Latest after 3 days of maturation the clarification and sedimentation is completed and the compact floc can be removed from the tank cone prior filtration (fig. 6-8).

Fig. 6: Precipitation after one hour *Fig. 7: Precipitation after three days* *Fig. 8: Pricipitation after trub separation*
Left to right: Reference Beer, Beer + Pectin dosage, Beer + Pectin/ Gallotannin dosage

The process diagram of kieselguhr filtration (fig. 9) with constant flow rate and filter aid dosage demonstrates the different raises of the pressure difference as an clearly indicator for the significant improved perfomance by pectin filtration or gallotannin/ pectin application direct after fermprocess entation (hose beer) and 3 days maturation time.

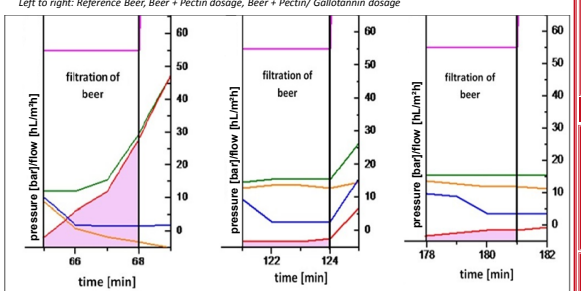


Fig. 9: Process diagram kieselguhr filtration : A reference, B beer pectin application, C beer -gallotannin/pectin application

RESULTS

During filtration gallotannin/pectin application shows a slightly faster increased in pressure difference against pectin caused by a slightly gallotannin over dosage (0.2 g/L).

To get a better insight in the most suitable gallotannin dosage further settling trials were carried out. Thereby the best clarification performance (fig. 10) - better than only pectin - could be observed in the range of < 0.1 g/L (0.05 g/L) gallotannin dosage with the additional advantage of a strong reduced floc volumen. In comparison to reference the final beer analyses show comparable results using only pectin but typical deviations using gallotannin/pectin in increased polyphenol /anthocyanogene contents and reduced nitrogen fractions, resulting in a higher colloidal beer stability. Furthermore, the final beers demonstrate a comparable or improved oxidative and colloidal stability.

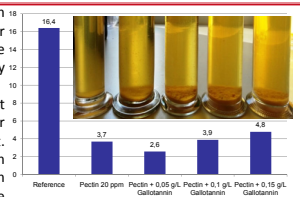


Fig. 10: Settling test: clarification after 24hr. Left to right: Reference Beer, Pectin 20 ppm, Pectin 20 ppm and Gallotannin (0.05; 0.1; 0.15 g/L)

Beer Analysis	unfiltered Beer			filtered Beer		
	Reference	Pectin	Pectin/ Gallotannin	Reference	Pectin	Pectin/ Gallotannin
Gravity, %Plato	11.5	11.5	11.5	10.6	10.6	10.5
Alcohol, % Vol.	4.8	4.8	4.8	4.4	4.4	4.4
Viscosity, mPa·s (12%)	1.693	1.657	1.737	1.683	1.642	1.728
Color, EBC	27.8	28.8	24.3	24.1	24.3	20.4
Bitter units	33	33	33	31	31	30
Total nitrogen, mg/L (12%)	896	894	813	855	854	803
MgSO4-N (12%)	165	150	105	165	148	93
FAN, mg/L	129	124	123	114	112	111
Polyphenoles, mg/L	276	272	281	242	243	247
Anthocyanogenes, mg/L	62	63	74	55	54	59
β-Glucanes, mg/L	438	439	436	401	402	399

Altogether the results show that the correct application of pectin or specific gallotannin/pectin combinations seems to be an efficient tool to reduce the maturation time and improve the filtration performance accompanied by reducing the amount of filter aids like kieselguhr or stabilizing agents.

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Acknowledgment:
The company **Herbstreith & Fox KG** is gratefully acknowledged for support.