



Physical grain characteristics, composition, and malting quality of CDC Copeland containing a high percentage of an undesigned DNA profile

Report prepared by

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Objective

The aim of this project was to determine if the presence of an undesigned DNA profile in CDC Copeland barley affected physical grain characteristics, composition, malting performance, and malting quality.

Materials and methods

Four samples of CDC Copeland barley, grown in 2022 in Saskatchewan, which had a relatively high number of kernels with an undesigned DNA profile were collected for this project (Table 1). Two other sets of CDC Copeland samples were selected from the Grain Research Laboratory's 2022 Harvest Survey of Malting Barley Program and from the Cargo Monitoring Program (Table 1). DNA was extracted from 144 randomly selected kernels from each CDC Copeland sample and the genetic makeup was determined by comparing the amplified simple sequence repeat (SSR) markers with those in the Grain Research Laboratory's reference catalogue for barley varieties registered in Canada. An undesigned DNA profile was found and quantified in several CDC Copeland barley samples (Table 1).

Samples were tested for moisture and protein by near-infrared technology (Infratec 1241, Foss). Germination energy was measured following the [ASBC method for barley germination](#). Test weight was determined according to the method outlined in the Canadian Grain Commission's [Official Grain Grading Guide](#) using a 0.125-litre cup due to limited sample size. Samples were scanned using a Cgrain Value™ seed analyzer (Cgrain AB, Uppsala, Sweden) to measure several physical grain characteristics including kernel weight and kernel dimensions (length, width). Kernel dimensions were measured in pixels and transformed into millimetres by the instrument software. Other physical parameters were derived through calculations by the Cgrain software. Barley was malted in an automated Phoenix Micromalting System and malt quality analysis was conducted according to the [ASBC Official Methods of Analysis](#).

Table 1 CDC Copeland malting barley samples used in this study.

Sample type	Province of origin	Kernels with undesignated DNA profile (%)
Samples with a high % of the undesignated DNA profile		
Sample 1	SK	16
Sample 2	SK	22
Sample 3	SK	17
Sample 4	SK	20
2022 Harvest Survey of Malting Barley Program		
Harvest 1	AB	3
Harvest 2	SK	4
Harvest 3	SK	3
Harvest 4	AB/SK	3
Harvest 5	SK	1
Harvest 6	AB	1
Harvest 7	SK	5
Harvest 8	MB/SK	4
2022 Cargo Monitoring Program		
Cargo 1	unk. ^a	3
Cargo 2	unk.	4
Cargo 3	unk.	0
Cargo 4	unk.	5
Cargo 5	unk.	3
Cargo 6	unk.	1
Cargo 7	unk.	3
Cargo 8	unk.	1

^a Unknown origin

Results

Physical characteristics and composition of CDC Copeland samples

1. Four CDC Copeland samples, grown in Saskatchewan in 2022 and selected for this project, contained a significantly higher percentage (16 to 22%) of the undesignated DNA profile compared to CDC Copeland samples collected from the 2022 Harvest Survey of Malting Barley Program (1 to 5% of the undesignated DNA) and from the Cargo Monitoring Program (0 to 5% of the undesignated DNA) (Table 1).
2. The commonly measured physical grain characteristics, including thousand kernel weight, plumpness, and test weight, of CDC Copeland samples with a high percentage of the undesignated DNA profile did not differ from the Harvest Survey of Malting Barley Program and Cargo Monitoring Program samples of CDC Copeland as shown in Figure 1. One exception was Sample 3, which was characterized by a slightly lower kernel weight compared to the other samples.



3. The protein content of CDC Copeland samples with a high percentage of the undesigned DNA profile ranged from 11.6 to 12.8% and fell within the range of protein content observed for the Harvest Survey of Malting Barley Program and Cargo Monitoring Program samples of CDC Copeland (Figure 2).
4. All four CDC Copeland samples with a high percentage of the undesigned DNA profile exhibited the required germination energy of $\geq 95\%$. Their germination rates, determined by the germination index, was also within the range observed for the Harvest Survey of Malting Barley Program and Cargo Monitoring Program samples of CDC Copeland (Figure 2).
5. Supplementary physical grain characteristics, including kernel weight, dimensions, and colour, were obtained with an imagine analyzer (Cgrain ValueTM). Several other parameters, such as kernel density, volume, and roundness, were derived from the measured physical characteristics (Table 2). None of the four CDC Copeland samples with a high percentage of the undesigned DNA profile exhibited unusual or unique physical parameters that would distinguish their kernels from those of the Harvest Survey of Malting Barley Program or Cargo Monitoring Program samples of CDC Copeland. The average kernel weight of Sample 3 was slightly lower compared to the other samples, but the difference was not statistically significant given a high degree of variability within each sample as indicated by relatively high standard deviation values (Table 2).

Malting and malt quality

1. All barley samples were malted using a Phoenix Micromalting System under identical conditions of steeping, germination and kilning. The parameters collected during malting included grain moisture after steeping and germination, malt yield, and roots yield. The results presented in Figure 3 do not indicate any unusual processing performance of the four CDC Copeland samples with a high percentage of the undesigned DNA profile.
2. The concentration of proteins in malt and the levels of starch degrading enzymes, as measured by diastatic power and α -amylase levels, for the four CDC Copeland samples with a high percentage of the undesigned DNA profile were generally within the range of values observed for the Harvest Survey of Malting Barley Program and Cargo Monitoring Program samples of CDC Copeland (Figure 4). One exception was Sample 3, which exhibited slightly lower level of α - amylase compared to other samples.
3. The level of malt extract and the concentration of β -glucans in the wort of the CDC Copeland samples with a high percentage of the undesigned DNA profile were within the range of values observed for the Harvest Survey of Malting Barley Program and Cargo Monitoring Program samples of CDC Copeland (Figure 5).
4. Sample 3 exhibited somewhat higher concentrations of soluble proteins and free amino nitrogen compounds in the wort compared to Samples 1, 2, and 4, and compared to the Harvest Survey of Malting Barley Program and Cargo Monitoring Program samples of CDC Copeland (Figure 6). These results point to a higher activity of proteolytic enzymes in the malt of Sample 3. A higher wort viscosity (Figure 5) and a darker colour of wort (Figure 6) of Sample 3 were likely associated with the higher concentration of proteins and free amino nitrogen content in the wort of Sample 3. The origin of a relatively higher proteolytic activity of malt of Sample 3 cannot be fully explained at this point. One plausible explanation could be related to a different and/or higher microbial load on Sample 3 barley. The presence of the undesigned DNA profile in Sample 3 is not likely to be associated with the higher activity of proteolytic enzymes in its malt since this sample did not contain the highest percentage of this DNA material.

Conclusion

The results of this study indicated that physical grain characteristics, composition, and malting quality of four



samples of CDC Copeland barley containing a relatively high percentage of the undesignated DNA profile (16 to 22%) did not differ from the properties exhibited by CDC Copeland barley with much lower percentages (0 to 5%) of this DNA material.

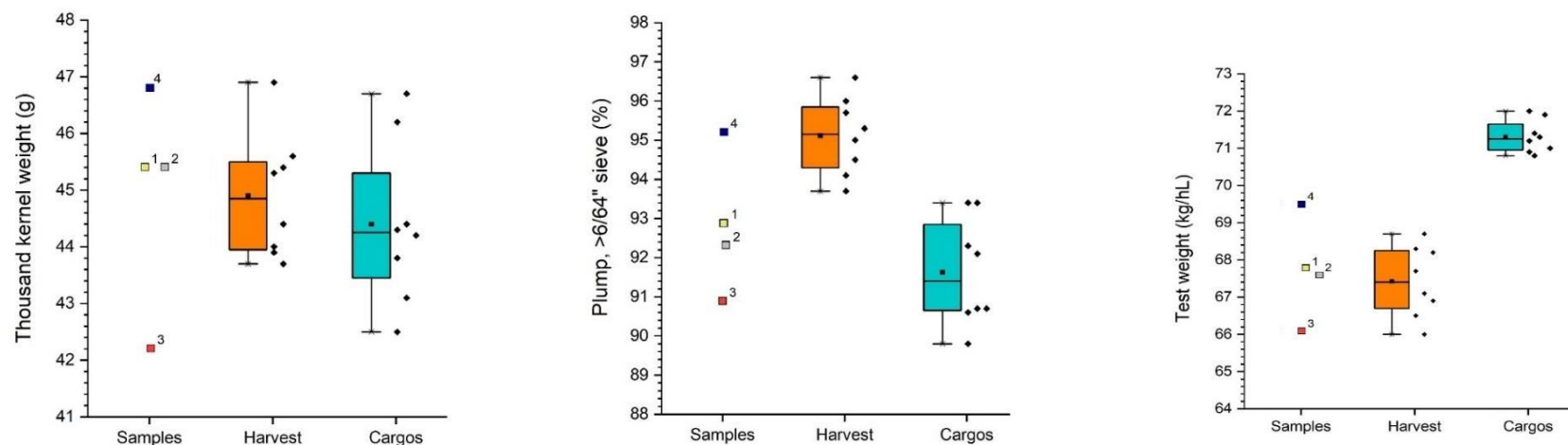


Figure 1 Physical grain characteristics of Samples 1 to 4 (with a high percentage of the undesigned DNA profile) in comparison to the Harvest Survey of Malting Barley Program and Cargo Monitoring Program samples of CDC Copeland.

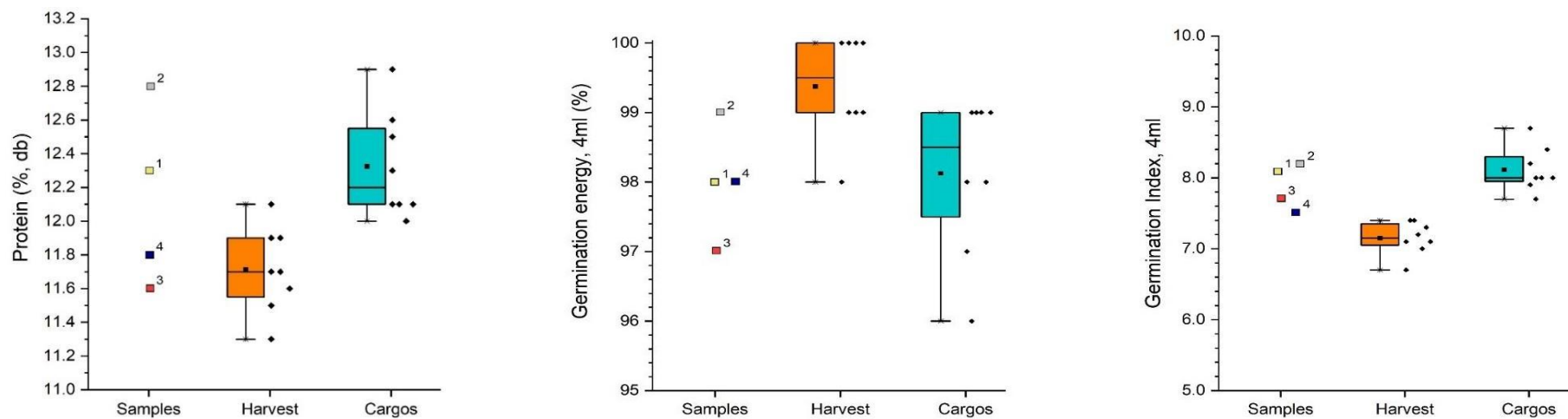


Figure 2 Protein content, germination energy, and germination index of barley grain of Samples 1 to 4 (with a high percentage of the undesigned DNA profile) in comparison to the Harvest Survey of Malting Barley Program and Cargo Monitoring Program samples of CDC Copeland.



Table 2 Germination energy, RVA viscosity, and supplementary physical grain characteristics of CDC Copeland barley samples.

Sample type	Province of origin	Kernels with undesignated DNA profile (%)	Germination energy 4 mL (%)	Final viscosity (RVU)	Supplementary grain characteristics																
					Kernel weight (mg)		Kernel density (g/cm)	Kernel area (mm²)		Kernel length (mm)		Kernel width (mm)		Kernel thickness (mm)		Kernel volume (mm³)		Kernel roundness		Kernel lightness ^a	
					Mean	SD		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Samples with a high % of the undesignated DNA profile																					
Sample 1	SK	16	92	160	46.4	9.6	1.186	18.9	3.4	8.41	0.84	3.61	0.32	2.80	0.31	39.1	8.1	0.5579	0.0461	0.543	
Sample 2	SK	22	89	159	44.6	9.6	1.166	18.9	3.4	8.37	0.82	3.59	0.34	2.76	0.33	38.2	8.2	0.5547	0.0503	0.542	
Sample 3	SK	17	85	152	42.0	9.3	1.153	18.3	3.3	8.31	0.78	3.51	0.34	2.68	0.33	36.4	8.0	0.5490	0.0487	0.535	
Sample 4	SK	20	90	151	46.2	10.1	1.197	18.7	3.6	8.24	0.95	3.64	0.34	2.79	0.31	38.6	8.4	0.5644	0.0558	0.544	
2022 Harvest Survey of Malting Barley Program																					
Harvest 1	AB	3	100	158	44.8	8.9	1.166	19.1	3.2	8.73	0.84	3.53	0.29	2.76	0.28	38.3	7.5	0.5469	0.0432	0.673	
Harvest 2	SK	4	94	155	46.0	9.4	1.168	19.3	3.5	8.60	0.93	3.65	0.33	2.80	0.31	39.4	7.9	0.5526	0.0536	0.577	
Harvest 3	SK	3	90	153	45.1	8.0	1.145	19.2	3.2	8.68	0.80	3.65	0.30	2.79	0.27	39.3	7.0	0.5474	0.0431	0.560	
Harvest 4	AB/SK	3	90	99	45.8	9.0	1.145	19.6	3.5	8.81	0.92	3.63	0.29	2.81	0.28	40.0	7.8	0.5469	0.0446	0.570	
Harvest 5	SK	1	96	146	45.4	8.7	1.152	19.6	3.4	8.73	1.00	3.57	0.26	2.80	0.25	39.4	7.5	0.5509	0.0492	0.596	
Harvest 6	AB	1	98	121	46.5	9.4	1.180	19.3	3.5	8.73	0.97	3.61	0.29	2.80	0.28	39.4	8.0	0.5491	0.0443	0.628	
Harvest 7	SK	5	93	98	45.2	8.6	1.155	19.3	3.4	8.65	0.78	3.61	0.31	2.78	0.29	39.1	7.4	0.5481	0.0423	0.535	
Harvest 8	MB/SK	4	90	156	43.7	8.8	1.170	18.4	3.4	8.36	0.90	3.60	0.31	2.77	0.29	37.4	7.5	0.5581	0.0484	0.568	
2022 Cargo Monitoring Program																					
Cargo 1	unk. ^b	3	88	93	41.9	10.0	1.173	17.9	3.4	8.12	0.74	3.47	0.37	2.66	0.34	35.5	8.3	0.5542	0.0450	0.583	
Cargo 2	unk.	4	92	121	46.7	9.9	1.217	18.7	3.4	8.27	0.69	3.60	0.34	2.75	0.32	38.4	8.1	0.5572	0.0423	0.596	
Cargo 3	unk.	0	91	86	45.5	10.0	1.210	18.6	3.3	8.22	0.72	3.56	0.34	2.73	0.32	37.6	8.2	0.5574	0.0452	0.579	
Cargo 4	unk.	5	87	45	43.8	9.7	1.207	17.9	3.4	8.09	0.66	3.52	0.37	2.68	0.33	36.3	8.0	0.5566	0.0448	0.576	
Cargo 5	unk.	3	90	125	43.4	10.3	1.202	17.9	3.4	8.08	0.70	3.51	0.37	2.67	0.35	36.1	8.4	0.5553	0.0461	0.605	
Cargo 6	unk.	1	88	97	44.6	11.0	1.204	18.3	3.4	8.12	0.70	3.54	0.37	2.70	0.36	37.1	9.1	0.5567	0.0478	0.577	
Cargo 7	unk.	3	92	115	43.7	9.8	1.195	18.0	3.3	8.10	0.73	3.52	0.37	2.71	0.34	36.6	8.2	0.5605	0.0489	0.580	
Cargo 8	unk.	1	70	89	43.9	10.0	1.203	18.0	3.4	8.04	0.70	3.52	0.36	2.71	0.34	36.5	8.3	0.5610	0.0470	0.576	

^a Lightness: 0=black; 1=white

^b unknown origin

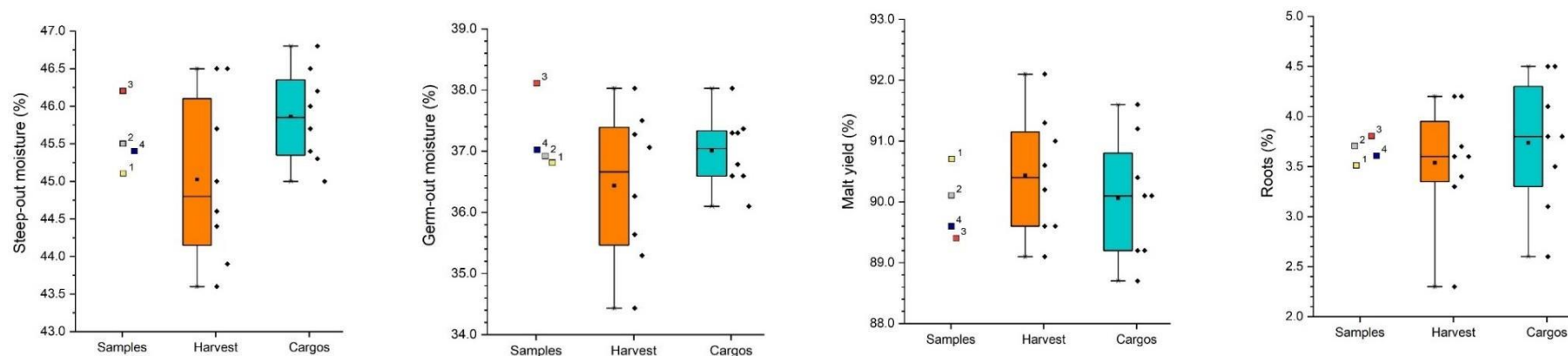


Figure 3 Malting performance parameters of Samples 1 to 4 (with a high percentage of the undesignated DNA profile) in comparison to the Harvest Survey of Malting Barley Program and Cargo Monitoring Program samples of CDC Copeland.

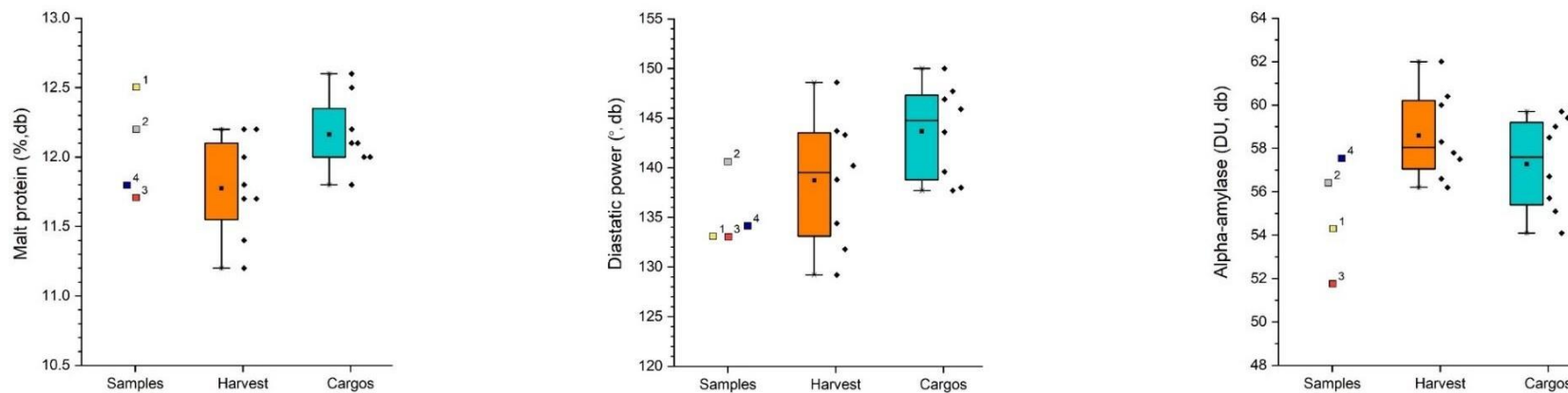


Figure 4 Malt protein content and enzyme levels in Samples 1 to 4 (with a high percentage of the undesignated DNA profile) in comparison to the Harvest Survey of Malting Barley Program and Cargo Monitoring Program samples of CDC Copeland.

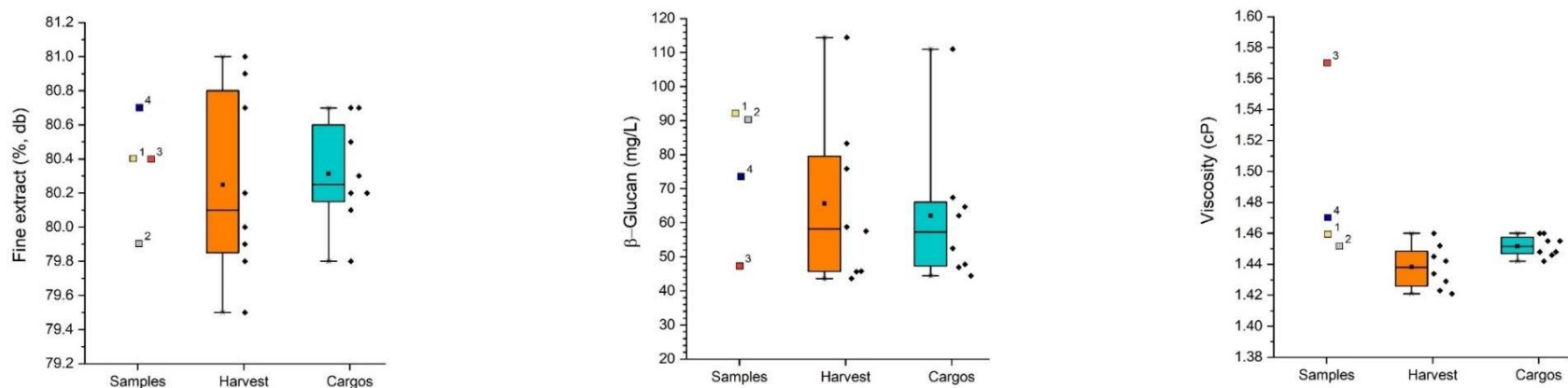


Figure 5 Malt extract, concentration of β -glucans in wort, and wort viscosity of the Samples 1 to 4 (with high percentage of the undesigned DNA profile) in comparison to the Harvest Survey of Malting Barley Program and Cargo Monitoring Program samples of CDC Copeland.

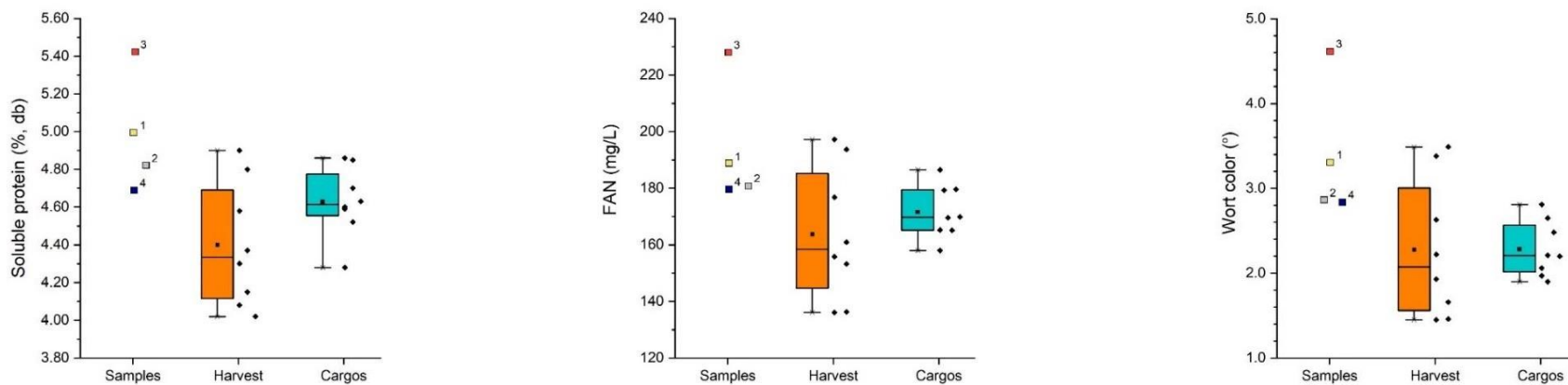


Figure 6 Concentration of soluble proteins and free amino nitrogen compounds (FAN) in wort and wort colour Samples 1 to 4 (with a high percentage of the undesigned DNA profile) in comparison to the Harvest Survey of Malting Barley Program and Cargo Monitoring Program samples of CDC Copeland.



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