Appendices

APPENDIX- A

Appendix A. 1 (a)
ANOVA for pH of retort-processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	0.0086	5	0.0017	6.39	0.0153	significant
A-Temperature	0.0076	1	0.0076	28.26	0.0011	
B-Time	0.0007	1	0.0007	2.72	0.1431	
AB	0.0000	1	0.0000	0.000	1.0000	
A^2	0.0001	1	0.0001	0.494	0.5048	
B^2	0.0001	1	0.0001	0.025	0.6310	
Residual	0.0019	7	0.0003			
Lack of Fit	0.0003	3	0.0001	0.238	0.8656	not significant
Pure Error	0.0016	4	0.0004			
Cor Total	0.0105	12				
Std. Dev.	0.0164	R-Squared	0.8202			
Mean	6.07	Adj R-Squared	0.6918			
C.V. %	0.2704	Pred R-Squared	0.5677			
PRESS	0.0045	Adeq Precision	8.2221			

Appendix A. 1 (b)
ANOVA for pH of PL processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	0.0003	9	0.0000	1.26	0.3876	not significant
A- Number of pulses	0.0002	1	0.0002	5.27	0.0554	
B-depth of sample	0.0000	1	0.0000	0.9672	0.3581	
C-sample source distance	0.0000	1	0.0000	1.72	0.2311	
AB	0.0000	1	0.0000	1.24	0.3026	
AC	2.250E-06	1	2.250E-06	0.0774	0.7889	
BC	2.250E-06	1	2.250E-06	0.0774	0.7889	
A^2	1.516E-06	1	1.516E-06	0.0521	0.8259	
B^2	0.0000	1	0.0000	0.6386	0.4505	
C^2	0.0000	1	0.0000	1.18	0.3141	
Residual	0.0002	7	0.0000			
Lack of Fit	0.0000	3	4.917E-06	0.1042	0.9534	not significant
Pure Error	0.0002	4	0.0000			
Cor Total	0.0005	16				
Std. Dev.	0.0054	R^2	0.6189			
Mean	6.09	Adj R^2	0.1289			
C.V. %	0.0885	Pred R^2	0.0058			
PRESS	0.0005	Adeq Precision	4.0198			

Appendix A. 2(a)

ANOVA for TSS of retort-processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	0.0007	5	0.0001	3.18	0.0815	not significant
A-Temperature	0.0004	1	0.0004	9.73	0.0168	
B-Time	0.0001	1	0.0001	2.58	0.1523	
AB	0.0000	1	0.0000	0.573	0.4737	
A^2	0.0001	1	0.0001	2.71	0.1435	
B^2	5.326E-06	1	5.326E-06	0.122	0.7371	
Residual	0.0003	7	0.0000			
Lack of Fit	0.0002	3	0.0001	3.76	0.1168	not significant
Pure Error	0.0001	4	0.0000			
Cor Total	0.0010	12				
Std. Dev.	0.0066	R-Squared	0.6946			
Mean	1.30	Adj R-Squared	0.4765			
C.V. %	0.5081	Pred R-Squared	-0.7276			
PRESS	0.0071	Adeq Precision	6.4270			

Appendix A. 2(b)

ANOVA for TSS of PL processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p- value Prob > F	
Model	0.0008	9	0.0001	0.7473	0.6657	not significant
A -Number of pulses	0.0002	1	0.0002	1.61	0.2452	
B- Depth of sample	1.084E-19	1	1.084E-19	8.723E-16	1.0000	
C- sample source distance	0.0002	1	0.0002	1.61	0.2452	
AB	0.0000	1	0.0000	0.2011	0.6673	
AC	0.0002	1	0.0002	1.81	0.2204	
BC	0.0000	1	0.0000	0.2011	0.6673	
A^2	0.0001	1	0.0001	0.6119	0.4597	
B^2	2.368E-06	1	2.368E-06	0.0191	0.8941	
C^2	0.0001	1	0.0001	0.6119	0.4597	
Residual	0.0009	7	0.0001			
Lack of Fit	0.0001	3	0.0000	0.2778	0.8395	not significant
Pure Error	0.0007	4	0.0002			
Cor Total	0.0017	16				
Std. Dev.	0.0111	R-Squared	0.4900			
Mean	1.30	Adj R-Squared	-0.1657			
C.V. %	0.8591	Pred R-Squared	-1.0664			
PRESS	0.0035	Adeq Precision	2.9238			

Appendix A. 3(a)
ANOVA for titrable acidity of retort-processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	3.347E-07	5	6.694E-08	2.37	0.1456	not significant
A-Temperature	5.539E-08	1	5.539E-08	1.96	0.2040	
B-Time	3.125E-08	1	3.125E-08	1.11	0.3277	
AB	6.250E-08	1	6.250E-08	2.21	0.1804	
A^2	2.401E-08	1	2.401E-08	0.850	0.3871	
B^2	1.753E-07	1	1.753E-07	6.21	0.0415	
Residual	1.976E-07	7	2.823E-08			
Lack of Fit	6.961E-08	3	2.320E-08	0.725	0.5878	not significant
Pure Error	1.280E-07	4	3.200E-08			
Cor Total	5.323E-07	12				
Std. Dev.	0.0002	R-Squared	0.6288			
Mean	0.0353	Adj R-Squared	0.3636			
C.V. %	0.4766	Pred R-Squared	-0.3056			
PRESS	3.523E-005	Adeq Precision	4.0221			

Appendix A. 3(b)

ANOVA for titrable acidity of PL processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	1.435E-06	9	1.594E-06	2.69	0.1026	not significant
A-Number of pulses	3.125E-08	1	3.125E-08	0.5277	0.4911	
B-Depth of sample	4.050E-07	1	4.050E-07	6.84	0.0346	
C-Sample source distance	3.125E-08	1	3.125E-08	0.5277	0.4911	
AB	2.025E-07	1	2.025E-07	3.42	0.1069	
AC	1.600E-07	1	1.600E-07	2.7	0.1442	
BC	2.500E-09	1	2.500E-09	0.0422	0.843	
A^2	1.364E-07	1	1.364E-07	2.3	0.1728	
B^2	1.917E-07	1	3.917E-07	6.61	0.0369	
C^2	2.695E-08	1	2.695E-08	0.4551	0.5216	
Residual	4.145E-07	7	5.921E-08			
Lack of Fit	4.025E-07	3	1.342E-07	44.72	0.0016	not significant
Pure Error	1.200E-08	4	3.000E-09			
Cor Total	1.849E-06	16				
Std. Dev.	0.0002	R-Squared	0.7759			
Mean	0.0354	Adj R-Squared	0.4877			
C.V. %	0.6875	Pred R-Squared	-2.4923			
PRESS	6.46E-06	Adeq Precision	5.0232			

Appendix A. 4(a)

ANOVA for total carbohydrate content of retort-processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	0.0002	5	0.0000	1.22	0.3921	not significant
A-Temperature	0.0001	1	0.0001	1.25	0.3004	
B-Time	0.0001	1	0.0001	2.50	0.1579	
AB	0.0000	1	0.0000	0.0000	1.0000	
A^2	0.0001	1	0.0001	1.32	0.2891	
B^2	0.0001	1	0.0001	1.32	0.2891	
Residual	0.0003	7	0.0000			
Lack of Fit	0.0002	3	0.0001	3.33	0.1376	not significant
Pure Error	0.0001	4	0.0000			
Cor Total	0.0005	12				
Std. Dev.	0.0063	R-Squared	0.4647			
Mean	22.65	Adj R-Squared	0.0824			
C.V. %	0.0279	Pred R-Squared	-1.9579			
PRESS	0.0015	Adeq Precision	2.8094			

Appendix A. 4(b)

ANOVA for total carbohydrate content of PL processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	0.0013	9	0.0001	2.99	0.0812	not significant
A-Number of pulses	0.0000	1	0.0000	1.06	0.3373	
B-Depth of sample	0.0000	1	0.0000	1.06	0.3373	
C-Sample source distance	0.0000	1	0.0000	0.0000	1.0000	
AB	0.0000	1	0.0000	0.5303	0.4901	
AC	0.0006	1	0.0006	13.26	0.0083	
BC	0.0000	1	0.0000	0.5303	0.4901	
A^2	2.63E-07	1	2.63E-07	0.0056	0.9425	
B^2	0.0004	1	0.0004	8.49	0.0225	
C^2	0.0001	1	0.0001	2.46	0.1606	
Residual	0.0003	7	0.0000			
Lack of Fit	0.0001	3	0.0000	0.2381	0.866	not significant
Pure Error	0.0003	4	0.0001			
Cor Total	0.0016	16				
Std. Dev.	0.0069	R-Squared	0.7938			
Mean	22.65	Adj R-Squared	0.5286			
C.V. %	0.0303	Pred R-Squared	0.2266			
PRESS	0.0012	Adeq Precision	6.1716			

Appendix A. 5(a)
ANOVA for vitamin C content of retort-processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	1.10	5	0.2190	18.70	0.0006	significant
A-Temperature	0.8717	1	0.8717	74.41	< 0.0001	
B-Time	0.0764	1	0.0764	6.52	0.0379	
AB	0.0020	1	0.0020	0.1729	0.6900	
A^2	0.1057	1	0.1057	9.03	0.0198	
B^2	0.0573	1	0.0573	4.89	0.0627	
Residual	0.0820	7	0.0117			
Lack of Fit	0.0303	3	0.0101	0.7807	0.5633	not significant
Pure Error	0.0517	4	0.0129			
Cor Total	1.18	12				
Std. Dev.	0.1082	R-Squared	0.9303			
Mean	3.94	Adj R-Squared	0.8806			
C.V. %	2.75	Pred R-Squared	0.7484			
PRESS	0.2962	Adeq Precision	12.914			

Appendix A. 5(b)
ANOVA for vitamin C content of PL processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	0.0076	9	0.0008	19.02	0.0004	significant
A-Number of pulses	0.0011	1	0.0011	25.37	0.0015	
B-Depth of sample	0.003	1	0.003	67.54	< 0.0001	
C-Sample source distance	0.0000	1	0.0000	1.12	0.3242	
AB	6.25E-06	1	6.25E-06	0.1406	0.7188	
AC	0.0000	1	0.0000	0.5622	0.4778	
BC	0.0000	1	0.0000	0.5622	0.4778	
A^2	0.0012	1	0.0012	26.17	0.0014	
B^2	0.0012	1	0.0012	26.17	0.0014	
C^2	0.0007	1	0.0007	15.7	0.0054	
Residual	0.0003	7	0.0000			
Lack of Fit	0.0000	3	0.0000	0.1488	0.9253	Not significant
Pure Error	0.0003	4	0.0001			
Cor Total	0.0079	16				
Std. Dev.	0.0067	R-Squared	0.9607			
Mean	4.95	Adj R-Squared	0.9102			
C.V. %	0.1347	Pred R-Squared	0.8817			
PRESS	0.0009	Adeq Precision	12.8563			

Appendix A. 6(a)
ANOVA for turbidity of retort-processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	1.40	5	0.2830	2.14	0.1742	Not significant
A-Temperature	0.7468	1	0.7468	5.65	0.0491	
B-Time	0.0087	1	0.0087	0.0661	0.8044	
AB	0.3782	1	0.3782	2.86	0.1345	
A^2	0.0090	1	0.0090	0.0683	0.8014	
B^2	0.2551	1	0.2551	1.93	0.2072	
Residual	0.9247	7	0.1321			
Lack of Fit	0.4002	3	0.1334	1.02	0.4730	not significant
Pure Error	0.5245	4	0.1311			
Cor Total	2.34	12				
Std. Dev.	0.3634	R-Squared	0.6048			
Mean	679.54	Adj R-Squared	0.3225			
C.V. %	0.0535	Pred R-Squared	-0.566			
PRESS	3.67	Adeq Precision	5.2879			

Appendix A. 6(b)
ANOVA for turbidity content of PL processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	47.18	9	5.24	2.1	0.1709	not significant
A-Number of pulses	0.4465	1	0.4465	0.1785	0.6854	
B-Depth of sample	10.63	1	10.63	4.25	0.0783	
C-Sample source distance	6.39	1	6.39	2.55	0.154	
AB	0.0256	1	0.0256	0.0102	0.9223	
AC	0.632	1	0.632	0.2526	0.6307	
BC	14.21	1	14.21	5.68	0.0486	
A^2	8	1	8	3.2	0.1168	
B^2	3.87	1	3.87	1.55	0.2536	
C^2	3.69	1	3.69	1.48	0.2639	
Residual	17.51	7	2.5			
Lack of Fit	17.49	3	5.83	1166.14	< 0.0001	significant
Pure Error	0.02	4	0.005			
Cor Total	64.7	16				
Std. Dev.	1.58	R-Squared	0.7293			
Mean	680.24	Adj R-Squared	0.3813			
C.V. %	0.2325	Pred R-Squared	-3.3265			
PRESS	279.91	Adeq Precision	6.3597			

Appendix A. 7
Colour values of retort-processed BPS juice

Treatment	Temperature(°C)	Time(min)	L*	a*	b*
1	80	20	32.78	-2.18	-4.81
2	70	25	36.29	-2.52	-0.11
3	90	15	32.50	-2.19	-2.12
4	80	12.92	35.38	-2.09	-2.53
5	80	27.07	32.80	-2.04	-4.03
6	65.85	20	39.03	-3.13	-3.07
7	80	20	30.71	-2.23	-3.27
8	80	20	34.78	-2.38	-4.61
9	90	25	31.56	-2.22	-2.17
10	80	20	34.71	-2.23	-4.77
11	94.14	20	31.29	-2.28	-2.02
12	80	20	34.81	-2.22	-4.50
13	70	15	37.77	-2.59	-0.09

Appendix A. 8
Colour values of PL processed BPS juice

Treatment	Number of pulses	Depth of sample (mm)	Sample-Source distance (cm)	L*	a*	b*
1	150	15	10	42.31	-2.64	-4.71
2	150	10	7	42.48	-3.43	-2.57
3	150	10	7	42.95	-3.02	-2.48
4	100	15	7	42.94	-3.55	-2.48
5	100	10	4	42.95	-3.02	-2.48
6	150	15	4	42.95	-3.02	-2.48
7	150	5	4	42.48	-3.43	-2.57
8	200	5	7	42.54	-2.70	-4.49
9	200	10	10	42.95	-3.56	-2.48
10	100	5	7	42.31	-2.64	-4.71
11	150	10	7	42.94	-3.55	-2.48
12	100	10	10	42.48	-3.43	-2.57
13	150	10	7	42.54	-2.70	-4.49
14	200	15	7	42.95	-3.02	-2.48
15	200	10	4	42.94	-3.55	-2.48
16	150	10	7	42.95	-3.02	-2.48
17	150	5	10	42.95	-3.02	-2.48

Appendix A. 9(a)
ANOVA for ΔE of retort-processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	34.14	5	6.83	8.63	0.0066	significant
A-Temperature	29.33	1	29.33	37.05	0.0005	
B-Time	1.80	1	1.80	2.27	0.1755	
AB	0.2070	1	0.2070	0.2615	0.6248	
A^2	2.17	1	2.17	2.75	0.1415	
B^2	0.9601	1	0.9601	1.21	0.3072	
Residual	5.54	7	0.7917			
Lack of Fit	0.5240	3	0.1747	0.1392	0.9314	Not significant
Pure Error	5.02	4	1.25			
Cor Total	39.69	12				
Std. Dev.	0.8898	R-Squared	0.8604			
Mean	8.80	Adj R-Squared	0.7606			
C.V. %	10.11	Pred R-Squared	0.7086			
PRESS	11.57	Adeq Precision	8.9601			

Appendix A. 9(b)
ANOVA for ΔE of PL processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	0.2513	9	0.0279	61.94	< 0.0001	significant
A-Number of pulses	0.1176	1	0.1176	260.95	< 0.0001	
B-Depth of sample	0.0882	1	0.0882	195.69	< 0.0001	
C-Sample source distance	0.0066	1	0.0066	14.67	0.0065	
AB	0.0042	1	0.0042	9.37	0.0183	
AC	0.0009	1	0.0009	2	0.2005	
BC	0.0072	1	0.0072	16.03	0.0052	
A^2	0.0089	1	0.0089	19.77	0.003	
B^2	0.0073	1	0.0073	16.09	0.0051	
C^2	0.011	1	0.011	24.3	0.0017	
Residual	0.0032	7	0.0005			
Lack of Fit	0.0029	3	0.001	13.69	0.0143	significant
Pure Error	0.0003	4	0.0001			
Cor Total	0.2544	16				
Std. Dev.	0.0212	R-Squared	0.9876			
Mean	0.9259	Adj R-Squared	0.9717			
C.V. %	2.29	Pred R-Squared	0.8175			
PRESS	0.0464	Adeq Precision	27.7902			

Appendix A. 10(a)
ANOVA for bacterial log reduction of retort-processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	0.0309	5	0.0062	20.02	0.0005	significant
A-Temperature	0.0164	1	0.0164	53.16	0.0002	
B-Time	0.0001	1	0.0001	0.4262	0.5347	
AB	0.0020	1	0.0020	6.57	0.0374	
A^2	0.0047	1	0.0047	15.40	0.0057	
B^2	0.0091	1	0.0091	29.44	0.0010	
Residual	0.0022	7	0.0003			
Lack of Fit	0.0008	3	0.0003	0.8471	0.0278	Not significant
Pure Error	0.0013	4	0.0003			
Cor Total	0.0330	12				
Std. Dev.	0.0176	R-Squared	0.9346			
Mean	6.25	Adj R-Squared	0.8880			
C.V. %	0.2809	Pred R-Squared	0.7570			
PRESS	0.0080	Adeq Precision	11.5448			

Appendix A. 10(b)
ANOVA for bacterial log reduction of PL processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	21.7	9	2.41	6.55	0.0107	significant
A-Number of pulses	8.84	1	8.84	24.02	0.0018	
B-Depth of sample	6.09	1	6.09	16.55	0.0048	
C-Sample source distance	0.0045	1	0.0045	0.0123	0.9149	
AB	0.0182	1	0.0182	0.0495	0.8302	
AC	0.9409	1	0.9409	2.56	0.1539	
BC	0.002	1	0.002	0.0055	0.9429	
A^2	0.0843	1	0.0843	0.2291	0.6468	
B^2	0.1203	1	0.1203	0.3268	0.5854	
C^2	5.39	1	5.39	14.65	0.0065	
Residual	2.58	7	0.368			
Lack of Fit	2.53	3	0.8438	75.54	0.0006	significant
Pure Error	0.0447	4	0.0112			
Cor Total	24.28	16				
Std. Dev.	0.6066	R-Squared	0.8939			
Mean	6.65	Adj R-Squared	0.7575			
C.V. %	9.12	Pred R-Squared	-0.6711			
PRESS	40.57	Adeq Precision	9.5994			

Appendix A. 11(a)
ANOVA for yeast and mould reduction of retort-processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	0.0256	5	0.0051	27.04	0.0002	significant
A-Temperature	0.0183	1	0.0183	96.42	< 0.0001	
B-Time	0.0000	1	0.0000	0.2208	0.6527	
AB	0.0000	1	0.0000	0.1321	0.7270	
A^2	0.0020	1	0.0020	10.62	0.0139	
B^2	0.0061	1	0.0061	31.98	0.0008	
Residual	0.0013	7	0.0002			
Lack of Fit	0.0006	3	0.0002	1.12	0.4399	Not significant
Pure Error	0.0007	4	0.0002			
Cor Total	0.0269	12				
Std. Dev.	0.0138	R-Squared	0.9508			
Mean	6.14	Adj R-Squared	0.9156			
C.V. %	0.2239	Pred R-Squared	0.7984			
PRESS	0.0054	Adeq Precision	14.4540			

Appendix A. 11(b)
ANOVA for yeast and mould reduction of PL processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	21.69	9	2.41	5.32	0.0192	significant
A-Number of pulses	10.76	1	10.76	23.75	0.0018	
B-Depth of sample	5.09	1	5.09	11.23	0.0122	
C-Sample source distance	0.0005	1	0.0005	0.001	0.9757	
AB	0.0225	1	0.0225	0.0496	0.83	
AC	0.5329	1	0.5329	1.18	0.3141	
BC	0.0016	1	0.0016	0.0035	0.9543	
A^2	0.2781	1	0.2781	0.6136	0.4591	
B^2	0.3968	1	0.3968	0.8756	0.3806	
C^2	4.27	1	4.27	9.42	0.0181	
Residual	3.17	7	0.4532			
Lack of Fit	3.1	3	1.03	56.04	0.001	significant
Pure Error	0.0737	4	0.0184			
Cor Total	24.86	16				

Std. Dev.	0.6732	R-Squared	0.8724
Mean	6.66	Adj R-Squared	0.7083
C.V. %	10.12	Pred R-Squared	-0.9989
PRESS	49.69	Adeq Precision	8.2313

Appendix A. 12(a)
ANOVA for *E-coli* reduction of retort-processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	0.0256	5	0.0051	27.04	0.0002	significant
A-Temperature	0.0183	1	0.0183	96.42	< 0.0001	
B-Time	0.0000	1	0.0000	0.2208	0.6527	
AB	0.0000	1	0.0000	0.1321	0.7270	
A^2	0.0020	1	0.0020	10.62	0.0139	
B^2	0.0061	1	0.0061	31.98	0.0008	
Residual	0.0013	7	0.0002			
Lack of Fit	0.0006	3	0.0002	1.12	0.4399	Not significant
Pure Error	0.0007	4	0.0002			
Cor Total	0.0269	12				
Std. Dev.	0.0138	R-Squared	0.9508			
Mean	6.14	Adj R-Squared	0.9156			
C.V. %	0.2239	Pred R-Squared	0.7984			
PRESS	0.0054	Adeq Precision	14.4540			

Appendix A. 12(b)
ANOVA for *E-coli* reduction of PL processed BPS

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	32.68	9	3.63	17.65	0.0005	significant
A-Number of pulses	15.88	1	15.88	77.17	< 0.0001	
B-Depth of sample	6.94	1	6.94	33.72	0.0007	
C-Sample source distance	2.18	1	2.18	10.62	0.0139	
AB	0.5852	1	0.5852	2.84	0.1355	
AC	0.1296	1	0.1296	0.63	0.4534	
BC	1.14	1	1.14	5.57	0.0504	
A^2	1.75	1	1.75	8.49	0.0225	
B^2	1.52	1	1.52	7.39	0.0299	
C^2	2.72	1	2.72	13.21	0.0084	
Residual	1.44	7	0.2057			
Lack of Fit	1.44	3	0.4799	3691.22	< 0.0001	significant
Pure Error	0.0005	4	0.0001			
Cor Total	34.12	16				
Std. Dev.	0.4536	R-Squared	0.9578			
Mean	4.17	Adj R-Squared	0.9035			
C.V. %	10.87	Pred R-Squared	0.3249			
PRESS	23.03	Adeq Precision	13.4531			

Appendix A. 13(a)
ANOVA for PPO inactivation of retort-processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	0.2872	5	0.0574	11.53	0.0028	significant
A-Temperature	0.0720	1	0.0720	14.44	0.0067	
B-Time	0.0124	1	0.0124	2.49	0.1588	
AB	0.0650	1	0.0650	13.05	0.0086	
A^2	0.0006	1	0.0006	0.1260	0.7331	
B^2	0.1325	1	0.1325	26.95	0.0013	
Residual	0.0349	7	0.0050			
Lack of Fit	0.0120	3	0.0040	0.6955	0.6014	Not significant
Pure Error	0.0229	4	0.0057			
Cor Total	0.3221	12				
Std. Dev.	0.0706	R-Squared	0.8917			
Mean	96.26	Adj R-Squared	0.8144			
C.V. %	0.0733	Pred R-Squared	0.6249			
PRESS	0.1208	Adeq Precision	11.3302			

Appendix A. 13(b)
ANOVA for PPO inactivation of PL processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	0.0077	9	0.0009	19.08	0.0004	significant
A-Number of pulses	0.0012	1	0.0012	25.68	0.0015	
B-Depth of sample	0.0030	1	0.003	67.82	< 0.0001	
C-Sample source distance	0.0000	1	0.0000	1.11	0.3261	
AB	9.00E-06	1	9.00E-06	0.2006	0.6677	
AC	0.0000	1	0.0000	0.5573	0.4797	
BC	0.0000	1	0.0000	0.5573	0.4797	
A^2	0.0012	1	0.0012	26.34	0.0014	
B^2	0.0012	1	0.0012	26.34	0.0014	
C^2	0.0007	1	0.0007	15.26	0.0059	
Residual	0.0003	7	0.0000			
Lack of Fit	0.0000	3	0.0000	0.1619	0.9167	Not significant
Pure Error	0.0003	4	0.0001			
Cor Total	0.0080	16				
Std. Dev.	0.0067	R-Squared	0.9608			
Mean	98.95	Adj R-Squared	0.9105			
C.V. %	0.0068	Pred R-Squared	0.8775			
PRESS	0.0010	Adeq Precision	12.9458			

Appendix A. 14(a)
ANOVA for POD inactivation of retort-processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	0.3110	5	0.0622	13.91	0.0016	significant
A-Temperature	0.0720	1	0.0720	16.09	0.0051	
B-Time	0.0200	1	0.0200	4.47	0.0724	
AB	0.0650	1	0.0650	14.54	0.0066	
A^2	0.0010	1	0.0010	0.2241	0.6504	
B^2	0.1473	1	0.1473	32.94	0.0007	
Residual	0.0313	7	0.0045			
Lack of Fit	0.0084	3	0.0028	0.4873	0.7094	Not significant
Pure Error	0.0229	4	0.0057			
Cor Total	0.3423	12				
Std. Dev.	0.0669	R-Squared	0.9086			
Mean	98.35	Adj R-Squared	0.8433			
C.V. %	0.0680	Pred R-Squared	0.7214			
PRESS	0.0954	Adeq Precision	12.4142			

Appendix A. 14(b)
ANOVA for POD inactivation of PL processed BPS juice

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	0.2559	9	0.0284	22.96	0.0002	significant
A-Number of pulses	0.0421	1	0.0421	33.95	0.0006	
B-Depth of sample	0.1012	1	0.1012	81.75	< 0.0001	
C-Sample source distance	0.0013	1	0.0013	1.01	0.3485	
AB	0.0009	1	0.0009	0.7266	0.4222	
AC	0.0004	1	0.0004	0.323	0.5876	
BC	0.0009	1	0.0009	0.7266	0.4222	
A^2	0.0345	1	0.0345	27.84	0.0012	
B^2	0.0425	1	0.0425	34.34	0.0006	
C^2	0.0209	1	0.0209	16.9	0.0045	
Residual	0.0087	7	0.0012			
Lack of Fit	0.0029	3	0.001	0.6876	0.6051	Not significant
Pure Error	0.0057	4	0.0014			
Cor Total	0.2646	16				

Std. Dev.	0.20	R-Squared	0.9672
Mean	3.15	Adj R-Squared	0.9251
C.V. %	6.50	Pred R-Squared	0.7878
PRESS	0.0561	Adeq Precision	14.4857

APPENDIX- B

Score card for sensory evaluation

SENSORY SCORE CARD

Department of Processing and Food Engineering KCAEFT, Tavanur

Name of judge: **Date:**

You are requested to assess the product in terms of general acceptability on a 9 point Hedonic scale.

Characteristics	Sample A	Sample B
Appearance		
Colour		
Smell		
Taste		
Overall Acceptability		

Score system:

Dislike extremely: 1, Dislike very much: 2, Dislike moderately: 3, Dislike slightly: 4

Neither like nor dislike: 5, Like slightly: 6, Like moderately: 7, Like very much: 8

Like extremely: 9

Comments if any:

Signature

Appendix B.1 Mean sensory scores of BPS juice samples

Sample	Appearance	Colour	Smell	Taste	Overall acceptability
Fresh	7± 0.02	7± 0.02	9± 0.02	9± 0.03	9± 0.01
Retort process	8.5± 0.02	8± 0.01	7.5± 0.02	7.5± 0.01	7.5± 0.02
PL process	9± 0.03	9± 0.03	9± 0.01	8.5± 0.02	9± 0.02

APPENDIX- C

SHELF-LIFE ANALYSIS

Changes in physicochemical and microbial properties of retort and PL processed BPS juice during storage

Parameter	Storage days	Treatment		
		Control	Retort	PL treated
pH	0	6.48±0.01	6.09±0.10	6.10±0.00
	5	5.57±0.00	6.00±0.00	6.05±0.00
	10	5.00±0.10	5.87±0.00	6.00±0.10
	15	4.61±0.00	5.63±0.10	6.00±0.00
	20	4.01±0.00	5.31±0.00	5.82±0.01
	25	3.70±0.10	5.02±0.00	5.60±0.00
	30	3.11±0.00	4.86±0.01	5.35±0.00
	35	2.52±0.00	4.60±0.00	5.16±0.10
	40	2.00±0.01	4.25±0.10	5.02±0.00
	45	1.71±0.00	4.00±0.00	4.86±0.00
	50	1.56±0.00	3.88±0.00	4.71±0.01
	55	1.30±0.10	3.60±0.00	4.55±0.00
	60	1.22±0.00	3.48±0.01	4.20±0.00
	65	1.10±0.00	3.30±0.00	3.96±0.10
	70	1.00±0.10	3.19±0.00	3.69±0.00
	75	1.00±0.00	2.93±0.10	3.30±0.00

	80	1.00±0.10	2.78±0.00	3.00±0.01
TSS (°Bx)	0	1.30±0.01	1.29±0.00	1.31±0.10
	5	1.07±0.00	1.15±0.10	1.307±0.01
	10	0.85±0.00	1.087±0.00	1.29±0.00
	15	0.736±0.00	1.063±0.10	1.282±0.00
	20	0.65±0.10	1.05±0.00	1.274±0.00
	25	0.583±0.00	1.044±0.00	1.262±0.00
	30	0.46±0.00	1.029±0.00	1.25±0.10
	35	0.30±0.10	1.017±0.00	1.24±0.00
	40	0.273±0.00	0.96±0.10	1.23±0.00
	45	0.19±0.10	0.821±0.00	1.19±0.10
	50	0.11±0.00	0.719±0.00	1.08±0.00
	55	0.09±0.10	0.60±0.00	1.05±0.00
	60	0.082±0.00	0.431±0.00	1.02±0.10
	65	0.07±0.10	0.329±0.00	0.81±0.00
	70	0.063±0.00	0.28±0.10	0.65±0.00
	75	0.05±0.00	0.16±0.00	0.44±0.00
	80	0.034±0.00	0.10±0.00	0.22±0.01
Titrable acidity (mg/100ml)	0	0.0320±0.10	0.0360±0.00	0.0350±0.10
	5	0.0459±0.00	0.0398±0.01	0.0371±0.00
	10	0.0582±0.00	0.0431±0.00	0.0402±0.10

	15	0.0664±0.01	0.0477±0.10	0.0438±0.00
	20	0.0742±0.00	0.0519±0.00	0.0466±0.01
	25	0.0856±0.00	0.0546±0.10	0.0484±0.00
	30	0.0963±0.10	0.0595±0.00	0.051±0.00
	35	0.1530±0.00	0.0618±0.00	0.0546±0.10
	40	0.2792±0.00	0.0664±0.10	0.0585±0.00
	45	0.3421±0.10	0.0697±0.00	0.0623±0.10
	50	0.3988±0.00	0.0731±0.01	0.066±0.00
	55	0.4754±0.01	0.077±0.00	0.0697±0.01
	60	0.5768±0.00	0.0826±0.10	0.073±0.00
	65	0.6946±0.00	0.0864±0.00	0.0759±0.00
	70	0.7645±0.10	0.0942±0.01	0.0791±0.00
	75	0.8750±0.00	0.0986±0.00	0.0856±0.00
	80	0.9843±0.00	0.121±0.00	0.0898±0.10
Carbohydrate (%)	0	22.66±0.01	22.64±0.00	22.66±0.01
	5	20.48±0.00	22.53±0.10	22.66±0.00
	10	18.58±0.10	22.43±0.00	22.63±0.10
	15	17.42±0.00	22.28±0.00	22.60±0.00
	20	15.71±0.00	21.72±0.00	22.58±0.01
	25	13.53±0.00	21.03±0.01	22.51±0.00
	30	12.81±0.00	20.77±0.00	22.46±0.00
	35	11.65±0.10	20.00±0.00	22.35±0.00

	40	9.93±0.00	19.53±0.10	22.22±0.00
	45	9.00±0.00	18.22±0.00	22.04±0.10
	50	7.87±0.00	17.73±0.00	21.70±0.00
	55	6.55±0.00	16.58±0.10	20.64±0.00
	60	5.07±0.10	15.43±0.00	19.50±0.10
	65	4.66±0.00	14.80±0.10	18.43±0.00
	70	3.78±0.00	13.22±0.00	17.70±0.00
	75	1.69±0.01	12.70±0.00	16.20±0.00
	80	0.85±0.00	11.44±0.00	15.53±0.10
Vitamin C (mg/100ml)	0	4.89±0.10	4.079±0.00	4.92±0.10
	5	4.54±0.00	4.00±0.10	4.90±0.00
	10	3.20±0.01	3.82±0.00	4.901±0.10
	15	2.44±0.00	3.75±0.01	4.84±0.00
	20	2.27±0.10	3.608±0.00	4.8±0.00
	25	2.09±0.00	3.54±0.00	4.71±0.01
	30	1.845±0.00	3.40±0.10	4.65±0.00
	35	1.60±0.10	3.27±0.00	4.53±0.00
	40	1.44±0.00	3.11±0.00	4.42±0.00
	45	1.32±0.00	2.95±0.00	4.36±0.00
	50	1.20±0.01	2.80±0.00	4.20±0.10
	55	1.04±0.00	2.77±0.10	4.10±0.00
	60	0.80±0.00	2.61±0.00	4.08±0.00

	65	0.54±0.00	2.49±0.00	3.85±0.00
	70	0.37±0.10	2.30±0.00	3.60±0.10
	75	0.196±0.00	2.206±0.10	3.52±0.00
	80	0.10±0.00	2.00±0.00	3.39±0.00
Turbidity (NTU)	0	682.8±0.01	682.50±0.00	683.00±0.10
	5	681.0±0.00	682.20±0.10	683.00±0.00
	10	679.0±0.10	682.50±0.00	682.60±0.10
	15	661.5±0.00	682.00±0.10	682.00±0.00
	20	651.0±0.10	673.00±0.00	681.50±0.01
	25	642.0±0.00	672.50±0.00	680.00±0.00
	30	631.2±0.00	671.00±0.01	678.70±0.00
	35	631.0±0.10	668.70±0.00	674.40±0.00
	40	620.0±0.00	661.40±0.00	689.00±0.00
	45	611.2±0.00	658.00±0.00	683.00±0.00
	50	600.0±0.00	651.20±0.00	681.00±0.10
	55	559.7±0.00	647.00±0.00	665.70±0.00
	60	521.0±0.10	641.90±0.00	653.00±0.10
	65	509.2±0.00	638.00±0.10	630.00±0.00

	70	478.0±0.00	609.40±0.00	626.50±0.00
	75	354.0±0.00	552.70±0.10	610.00±0.00
	80	218.0±0.01	466.00±0.00	572.00±0.00
Total colour difference (ΔE)	0	0.00±0.00	0.00±0.00	0.00±0.00
	5	10.68±0.00	7.34±0.00	0.985±0.10
	10	10.92±0.00	7.47±0.00	1.09±0.00
	15	11.33±0.00	7.78±0.01	1.26±0.10
	20	12.45±0.00	8.01±0.00	1.31±0.00
	25	13.91±0.00	8.63±0.10	1.40±0.10
	30	15.06±0.00	8.90±0.00	1.55±0.00
	35	16.67±0.00	9.25±0.00	1.66±0.00
	40	17.80±0.00	9.96±0.10	1.73±0.00
	45	19.34±0.00	10.41±0.00	1.85±0.00
	50	20.88±0.00	10.90±0.00	1.90±0.00
	55	21.29±0.00	11.33±0.01	2.05±0.00
	60	23.60±0.00	11.80±0.00	2.20±0.01
	65	24.15±0.00	12.40±0.00	2.34±0.00
	70	26.02±0.00	12.98±0.00	2.41±0.00
	75	28.81±0.00	13.30±0.00	2.57±0.00
	80	30.77±0.00	13.91±0.10	2.63±0.10
	0	0.00	96.65±0.10	98.87±0.00

Polyphenol oxidase enzyme Inactivation (%)	5	80.80±0.00	96.51±0.00	98.82±0.10
	10	76.64±0.10	96.03±0.00	98.75±0.00
	15	71.00±0.00	95.00±0.00	97.44±0.10
	20	65.48±0.10	94.05±0.00	95.50±0.00
	25	59.20±0.00	93.62±0.00	94.72±0.00
	30	53.33±0.00	92.80±0.10	94.04±0.00
	35	46.29±0.10	91.33±0.00	91.60±0.00
	40	38.10±0.00	89.00±0.00	88.00±0.01
	45	29.55±0.00	85.87±0.00	85.50±0.00
	50	19.30±0.00	81.04±0.00	80.02±0.00
	55	15.84±0.00	77.10±0.00	77.70±0.00
	60	13.06±0.00	72.43±0.00	71.23±0.00
	65	10.50±0.10	69.85±0.00	68.00±0.00
	70	9.20±0.00	57.42±0.10	65.60±0.00
	75	8.60±0.00	54.70±0.00	62.00±0.00
	80	7.44±0.00	49.64±0.00	58.78±0.01
Peroxidase enzyme Inactivation (%)	0	0.00	98.43±0.10	99.67±0.00
	5	84.15±0.10	98.37±0.00	99.60±0.10

	10	80.23±0.00	98.29±0.10	99.50±0.00
	15	76.50±0.00	98.00±0.00	99.42±0.01
	20	70.11±0.00	97.66±0.00	99.33±0.00
	25	61.84±0.10	97.08±0.10	98.70±0.00
	30	52.00±0.00	96.49±0.00	98.01±0.00
	35	48.71±0.00	96.00±0.00	97.73±0.10
	40	35.09±0.00	95.50±0.00	97.11±0.00
	45	27.18±0.00	94.89±0.10	96.20±0.00
	50	20.12±0.00	93.60±0.00	95.46±0.01
	55	19.08±0.10	92.58±0.00	94.38±0.00
	60	16.54±0.10	90.30±0.00	93.00±0.00
	65	11.00±0.00	84.90±0.10	91.22±0.00
	70	10.40±0.00	79.54±0.00	87.50±0.00
	75	9.60±0.00	70.00±0.00	83.00±0.00
	80	8.80±0.00	65.24±0.00	76.87±0.00

APPENDIX-D

COST ANALYSIS OF RETORT-PROCESSED BPS JUICE

Cost of machineries	**Rupees/-**
Retorting autoclave	800000
Other machines including steam exhauster and continuous band sealer	100000
Cold storage	200000
Floor space 5 m^2	100000
Miscellaneous items	10000
Total cost	1210000

Assumptions

Life span (L) = 15 Years

Annual working hours(T) = 275 days (per day 16 h) =4400 h

Salvage value (S) = 10% of initial cost

Interest on initial cost (i) = 15% annually

Repairs and maintenance = 10% of initial cost

Insurance and taxes = 2% of initial cost

Electricity charge = Rs. 8/unit

Labour wages/person = Rs.700/day

Cost of a pouch = Rs.7/-

1. Fixed cost per year

a. Depreciation = $\frac{C-S}{L\times H}$ = $\frac{1210000-121000}{15\times 4400}$ = 16.5/h

b. Interest = $\frac{C+S}{2}\times\frac{i}{H}$ = $\frac{1210000+121000}{2}\times\frac{15}{100\times 4400}$ = 22.68/h

c. Insurance and taxes = 2% of initial cost

$$= \frac{2}{100X4400} \times 1210000 = 5.5/h$$

Total fixed cost = a+ b+ c= 16.5+22.68+5.5= 44.68/h

=Rs. 44.68/-

2. Total variable cost per year

i. Repairs and maintenance = 10% of initial cost

$$= \frac{10}{100X4400} \times 1210000 = 27.5/h$$

= Rs. 121000/-

ii. Electricity cost

a. Energy consumed by retort processing machine = 11 kwh
b. Energy consumed by steam exhauster and sealing machine = 3kwh
c. Total energy consumption = 14kwh
d. Cost of energy consumption per hour =Power× duration× cost of 1 unit

=14× 4400×8=492800/-

iii. Skilled assistants (4 person) = Rs. 700/day

= Rs.770000/-

iv. Raw material cost

1. Cost of banana pseudostem = Rs. 10/kg

= Rs. 1031250/-

2. No. of batches possible in a day = 22 batches
3. No. of pouches required in a day = 1500

v. Packaging cost = Rs. 10500/day

= Rs. 2887500/-

Total variable cost= i+ii+iii+iv+v = 121000+492800+770000+1031250+ 2887500

= 4532550/-

Therefore, total cost of production BPS juice per year = Fixed cost+ variable cost
= 196592+ 4532550
= Rs. 4729142/-

Cost of production of one pouch of BPS juice = Rs. 16/-
= Rs. 10.80/100 ml
= Rs. 108/l

COST ANALYSIS OF PL PROCESSED BPS JUICE

1. Fixed Costs

- Pulsed Light System Cost: ₹50,00,000
- Filling and Bottling Machine: ₹4,00,000
- **Total Initial Cost (C):** ₹54,00,000
- Useful Life: 15 years
- Salvage Value: 10% of initial cost
- Interest Rate on Initial Cost (r): 12% annually
- Repairs and Maintenance: 5% of initial cost
- Insurance and Taxes: 2% of initial cost
- Annual Working Hours (T): 2000 hours

Depreciation

Depreciation = (Initial Cost - Salvage Value) / Useful Life =

(₹54,00,000 - ₹5,40,000) / 15 = ₹3,24,000 per year

Interest on Average Investment

Interest on Average Investment =

[(Initial Cost + Salvage Value) / 2] × Interest Rate

Interest = [(₹54,00,000 + ₹5,40,000) / 2] × 0.12 = ₹3,55,680 per year

Insurance and Taxes

- Insurance and Taxes = 2% × ₹54,00,000 = ₹1,08,000 per year

Repairs and Maintenance

- Repairs and Maintenance = 5% × ₹54,00,000 = ₹2,70,000 per year

Total Fixed Cost Per Year

- Total Fixed Cost Per Year = ₹3,24,000 + ₹3,55,680 + ₹1,08,000 + ₹2,70,000
  = ₹10,57,680 per year

2. Variable Costs

- Electricity Cost = 6 kW × ₹5.5/unit × 2000 hours = ₹66,000 per year
- Labor Costs = ₹40,000 per year

3. Raw Material Costs

- Cost of Banana pseudostem = ₹10 per kg
- Cost per Bottle (100 ml of juice)= ₹37
- Cost of 500 ml PET Bottle for Packaging: ₹5

4. Total Costs

- Fixed Costs (Per Year)= ₹10,57,680
- Variable Costs (Per Year)= ₹66,000 (electricity) + ₹40,000 (labor)
  = ₹1,06,000
- **Total Annual Cost of Operation=** ₹10,57,680 + ₹1,06,000 = ₹11,63,680

5. Cost Per Bottle

- Assuming a capacity to produce 2000 bottles (500 ml each) annually, the cost per bottle for processing is:
  - **Cost per Bottle (Processing) = ₹11,63,680 / 2000 = ₹582 per bottle**
- Adding the cost of juice per bottle and the packaging cost (₹5):
  - **Total Cost per Bottle = ₹582 (Processing) + ₹37 (Juice) + ₹5 (Packaging)**
    = ₹624 per bottle

RETORT POUCH PACKAGING AND PULSED LIGHT TECHNOLOGY FOR PRESERVATION OF BANANA PSEUDOSTEM JUICE

By

VISHNUPRIYA M
(2021-18-012)

ABSTRACT OF THESIS

Submitted in partial fulfilment of the requirement for the degree of

MASTER OF TECHNOLOGY

IN

AGRICULTURAL ENGINEERING

(Processing and Food Engineering)

Faculty of Agricultural Engineering and Technology

Kerala Agricultural University

DEPARTMENT OF PROCESSING AND FOOD ENGINEERING

KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND FOOD TECHNOLOGY, TAVANUR - 679573, MALAPPURAM

KERALA, INDIA, 2022