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Abstract

Summary statistics and corresponding Spearman correlation coefficients are illustrated for various subsets of aromatic rough rice storage time and temperature data from (a) the College Station texture sensory panel, (b) the New Orleans aroma and flavor sensory panel, and (c) the Beaumont USDA-ARS Rice Quality Laboratory. These correlations represent the inclinations of seemingly-related measures of several attributes to “move together,” acting as an indicator of their associations with or impacts on one another.

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Correlation Measures for Rough Rice Storage Time and Temperature Component of Aromatic Rice Project

Introduction

This paper is a companion document to the paper, "Effects of Rough Rice Storage Time and Temperature on Aromatic Rice Grain Quality Characteristics" (Holcomb et al.). The sole intent of this document is to further enhance the description of data used in the Holcomb et al. paper. Simple summary statistics and corresponding Spearman correlation coefficients (Bhattacharyya and Johnson, p. 528) are illustrated for various subsets of the data used in the noted Holcomb et al. paper. Whereas the previous Holcomb et al. paper reported results separately for (a) the College Station texture sensory panel, (b) the New Orleans aroma and flavor sensory panel, and (c) the Beaumont USDA-ARS Rice Quality Laboratory, this document provides insights on the correlations among seemingly-related measures across the three data sources. These correlations represent the inclinations of these attributes to "move together" across storage effects, acting as an indicator of their associations with or impacts on one another. The subsets included are not exhaustive, but rather a simple attempt to enhance the information available to those interested. Readers unfamiliar with the terms used in describing the various data are referred to Goodwin et al.

Analysis of the textureometer data referred to in this paper were not included in the aforementioned Holcomb et al. paper. A forthcoming paper presents textureometer analyses similar to those reported in the Holcomb et al. paper for both (a) the rough rice storage and temperature and (b) the milled rice storage, temperature, and packaging data sets.

References

Bhattacharyya, G.K., and R.A. Johnson. *Statistical Concepts and Methods*. New York: John Wiley and Sons. 1977.

Goodwin, H.L., Jr., L.A. Koop, M.E. Rister, R.K. Miller, J.V. Maca, E. Chambers, M. Hollingsworth, K. Bett, B.D. Webb, and A. McClung. "Developing a Common Language for the U.S. Rice Industry: Linkages Among Breeders, Producers, Processors, and Consumers." Texas A&M University, Department of Agricultural Economics, TAMRC Technical Report No. CP 2-96, August 1996.

Holcomb, R.B., M.E. Rister, B.D. Webb, R.K. Miller, K. Bett, A. McClung, H.L. Goodwin, Jr., F. Dahm, L.A. Faltisek, J.W. Stansel, L.A. Koop, A.W. Sturdivant, J.V. Maca, J.P. Nichols, R.E. Branson, J. Delgado, J.B. Ward, and C. Gates. "Effects of Rough Rice Storage Time and Temperature on Aromatic Rice Grain Quality Characteristics." Texas Agricultural Market Research Center, Department of Agricultural Economics, Texas Agricultural Experiment Station, Texas A&M University System. College Station, TX. TAMRC Consumer Product Market Research Report No. CP 1-97. June 1997.

Table 1. Rice Textural Characteristics (and Raw Rice Color) Evaluated by the College Station Rice Texture/Color Descriptive Attribute Panel. [a, b]

Characteristic	Description	SAS Analysis Correlation Variable [c]	Abbreviated Variable Name
Adhesiveness	How sample holds together when first placed in the mouth.	MTE_AD	AD
Cohesiveness	Degree to which sample deforms rather than crumbles or breaks.	MTE_CO	CO
Hardness	Force required to bite through cooked rice with the molar teeth.	MTE_HA	HA
Toothpacking	Degree to which rice sticks on/in the surfaces of the teeth.	MTE_TO	TO
Starchy Coating	Amount of paste-like thickness perceived on the rice.	MTE_SC	SC
Surface Slickness	Maximum ease of passing the tongue over the rice surface.	MTE_SS	SS
Chewiness	Length of time needed to masticate rice for swallowing.	MTE_CH	CH
Uniformity of Bite	Degree to which rice changes from start to finish.	MTE_UB	UB
Cohesiveness of Mass	Maximum degree to which mass holds together during mastication.	MTE_CM	CM
Roughness	Amount and irregularity of the grains' surfaces, combined.	MTE_RO	RO
Residuals	Amount of particles remaining in the mouth after swallowing.	MTE_RE	RE
Raw Rice Color	Level of whiteness discernable by simply viewing the raw rice.	MTE_RR	RR

[a] Source of first two columns is Holcomb *et al.*, Table 1, p. 43.

[b] Textural characteristics and scales are in accordance with the rice attribute lexicon developed at Kansas State University (Goodwin *et al.*).

[c] Variable names are those used in the statistical analyses reported in Holcomb *et al.*

Table 2. Rice Aromas and Flavors Evaluated by the New Orleans Rice Aroma/Flavor Descriptive Attribute Panel. [a, b]

Characteristic	Description	SAS Analysis Correlation Variable [c]
Sewer/Animal Aroma	Immediate and distinct pungent aroma; sulfur-like or "piggy."	SWA
Floral Aroma	Similar to dried lilac and/or lavender; spicy floral.	FLA
Grain Aroma	Similar to corn, oats, wheat, or their combination.	GRA
Hay-Like Aroma	Dry, dusty; like freshly cut and dried grass.	HYA
Popcorn Aroma	The distinctive aroma of freshly popped popcorn.	PCA
Corn Aroma	Combined aromatics of corn kernels, milk, and germ.	CRA
Alfalfa Aroma	Dried, slightly earthy, slightly sweet; like dried alfalfa leaves and stems.	ALA
Dairy Aroma	Reminiscent of pasteurized cow's milk.	DRA
Sweet Aroma	Impression of sweetness given by the combined aromatics.	STA
Sewer/Animal Flavor	Sulfur-like (rotten eggs) or generic animal flavor.	SAN
Floral Flavor	Spicy flavor reminiscent of an old-fashioned sachet.	FLR
Popcorn Flavor	Slightly toasted and slightly sweet flavor of popcorn.	PCN
Grain Flavor	Reminiscent of a combination of grain flours and meals.	GRN
Dairy Flavor	Similar to pasteurized cow's milk.	DRY
Sweet Flavor	Impression of added sugar/sweetener.	SWT
Water-Like Flavor	Mouth feel of minerals and metallic components commonly associated with tap water.	WTL

[a] Source of first two columns is Holcomb *et al.*, Table 2, p. 44.

[b] Aromas, flavors, and scales are in accordance with the rice attribute lexicon developed at Kansas State University (Goodwin *et al.*).

[c] Variable names are those used in the statistical analyses reported in Holcomb *et al.*

Table 3. Physical and Chemical Properties Evaluated by the Beaumont USDA-ARS Rice Quality Lab.[a]

Characteristic	SAS Analysis Correlation Variable[b]	Abbreviated Variable Name
Grain Length	QINMSGL	GL
Grain Width	QINMSGW	GW
Length/Width Ratio	QINMSLW	LWR
Grain Thickness	QINMSGT	GT
Grain Weight	QINMSGE	GWT
% Chalky Kernels	QCA_CK	CK
Minimum Cooking Time	QTA_MT	MCT
Grain Elongation Ratio	QEA_ER	ER
Satake Whiteness	QWM_AW	AW
Alkali Spreading Value (1.7% KOH)	QSV17SA	AS17
Alkali Spreading Value (1.5% KOH)	QSV15SA	AS15
Milled Rice Protein	QPR_MI	MRP
Milled Rice Lipids	QLA_MI	MRL
Apparent Amylose	QAA_AA	AA
Soluble Amylose	QAA_SA	SA
Pasting Temperature	VRV_VI	PT
Peak Viscosity	VRV_PE	PV
Hot Paste	VRV_TR	HP
Cool Paste	VRV_VS	CP
Breakdown	VRV_DI	B
Setback	VRV_SE	S
Consistency	VRV_CO	C
2-Acetyl-1-Pyrroline	A_AP	2A1P

[a] Source of first column is Holcomb *et al.*, Table 6, p. 49.

[b] Variable names are those used in the statistical analyses reported in Holcomb *et al.*

Table 4. Textureometer Characteristics Evaluated at Time of College Station Rice Texture/Color Descriptive Attribute Panel Appraisals.

Characteristic	Description	SAS Analysis Correlation Variable
Adhesiveness	The force required to remove cooked rice that adheres to serving utensils and the mouth (especially the teeth) during eating.	MAD
Chewiness	Relating to the length of time required to masticate cooked rice at a constant rate of force application, to reduce it to a consistency suitable for swallowing.	MCH
Cohesiveness	The internal force holding a grain together before it breaks, when compressed between the teeth.	MCO
Gumminess	Denseness that persists throughout mastication; the energy required to disintegrate cooked rice to a state ready for swallowing. This term is a composite of hardness and cohesiveness.	MGU
Hardness	The force required to compress cooked rice between the molar teeth on the first chew.	MHA
Springiness	The degree to which cooked rice returns to its original shape once it has been compressed between the teeth.	MSP
Resistance	Initial resistance of the cooked rice grains to compression; also referred to as "initial modulus."	MMD

Table 5. Spearman Correlations Among Sensory Texture and Color Attributes Used to Determine the Effects of Rough Rice Storage Time and Temperature on Aromatic Rice Quality, Texas A&M Aromatic Rice Project, 1992-93. [a]

Variable [b]	AD	CH	CO	UB	HA	TO	CM	SC	SS	RO	RE	RR
Adhesiveness, AD	1.000											
Chewiness, CH	-0.057	1.000										
Cohesiveness, CO	0.075	0.195	1.000									
Uniform.of Bite, UB	0.128	-0.075	0.101	1.000								
Hardness, HA	-0.271* [c]	0.246*	0.061	-0.369*	1.000							
Toothpacking, TO	0.163	0.334*	0.333*	0.373*	-0.003	1.000						
Cohesiv of Mass, CM	0.479*	0.245*	0.325*	0.309*	-0.079	0.570*	1.000					
Starchy Coating, SC	0.412*	-0.007	0.270*	0.327*	-0.137	0.381*	0.464*	1.000				
Surface Slickness, SS	0.133	0.178	0.281*	0.399*	-0.080	0.505*	0.464*	0.561*	1.000			
Roughness, RO	-0.318*	0.250*	0.052	-0.012	0.400*	0.323*	0.102	-0.252*	-0.115	1.000		
Residuals, RE	0.068	0.258*	0.254*	0.274*	0.064	0.705*	0.394*	0.105	0.290*	0.404*	1.000	
Raw Rice Color, RR	0.166	-0.019	-0.056	-0.214	0.086	-0.074	-0.191	-0.044	-0.163	-0.138	0.042	1.000

[a] Prob > |R| under Ho: Rho=0 / N = 82.

[b] Refer to Table 1 on page 3 for a description of the respective variables.

[c] An * denotes a statistical significance at the .05 level or lower.

Table 6. Spearman Correlations Among Sensory Aroma and Flavor Attributes Used to Determine the Effects of Rough Rice Storage Time and Temperature on Aromatic Rice Quality, Texas A&M Aromatic Rice Project, 1992-93. [a]

Variable [b]	SWA	FLA	GRA	HYA	PCA	CRA	ALA	DRA	STA	SAN	GRN	PCN	FLR	DRY	WTL	SWT
Sewer/Animal Aroma, SWA	1.000															
Floral Aroma, FLA	0.637*[c]	1.000														
Grain Aroma, GRA	0.615*	0.578*	1.000													
Hay-Like Aroma, HYA	0.666*	0.530*	0.598*	1.000												
Popcorn Aroma, PCA	0.615*	0.551*	0.716*	0.586*	1.000											
Corn Aroma, CRA	0.457*	0.428*	0.524*	0.473*	0.598*	1.000										
Alfalfa Aroma, ALA	0.599*	0.643*	0.534*	0.575*	0.491*	0.414*	1.000									
Dairy Aroma, DRA	0.398*	0.284*	0.530*	0.431*	0.576*	0.637*	0.341*	1.000								
Sweet Aroma, STA	0.525*	0.677*	0.575*	0.484*	0.528*	0.483*	0.611*	0.386*	1.000							
Sewer/Animal Flavor, SAN	0.576*	0.574*	0.497*	0.451*	0.485*	0.403*	0.583*	0.259*	0.529*	1.000						
Grain Flavor, GRN	0.599*	0.543*	0.695*	0.564*	0.674*	0.550*	0.529*	0.538*	0.557*	0.512*	1.000					
Popcorn Flavor, PCN	0.520*	0.455*	0.582*	0.537*	0.754*	0.641*	0.438*	0.605*	0.440*	0.429*	0.624*	1.000				
Floral Flavor, FLR	0.559*	0.771*	0.486*	0.469*	0.499*	0.409*	0.602*	0.219*	0.688*	0.659*	0.489*	0.427*	1.000			
Dairy Flavor, DRY	0.476*	0.373*	0.548*	0.449*	0.601*	0.609*	0.402*	0.675*	0.423*	0.360*	0.561*	0.647*	0.324*	1.000		
Water-Like Flavor, WTL	0.606*	0.523*	0.681*	0.533*	0.720*	0.490*	0.453*	0.496*	0.481*	0.475*	0.645*	0.613*	0.478*	0.568*	1.000	
Sweet Flavor, SWT	0.682*	0.596*	0.646*	0.610*	0.654*	0.543*	0.550*	0.533*	0.612*	0.393*	0.654*	0.625*	0.515*	0.611*	0.620*	1.000

[a] Prob > |R| under Ho: Rho=0 / N = 837.

[b] Refer to Table 2 on page 4 for a description of the respective variables.

[c] An * denotes a statistical significance at the .05 level or lower.

Table 7. Spearman Correlations Among Physicochemical Attributes Used to Determine the Effect of Rough Rice Storage Time and Temperature on Aromatic Rice Quality, Texas A&M Aromatic Rice Project, 1992-93.[a]

Variable[b]	GL	GW	LWR	GT	GWT	CK	MCT	ER	AW	AS17	AS15	MRP	MRL	AA	SA	PT	PV	HP	CP	B	S	C
Grain Length, GL	1.000																					
Grain Width, GW	0.284*[c]	1.000																				
Length/Width Ratio, LWR	0.418*	-0.545*	1.000																			
Grain Thickness, GT	-0.164	0.196	-0.377*	1.000																		
Grain Weight, GWT	0.433*	0.267*	0.071	0.385*	1.000																	
% Chalky Kernels, CK	0.070	-0.385*	0.442*	-0.064	0.090	1.000																
Min Cooking Time, MCT	0.068	0.293*	-0.089	0.178	0.178	-0.124	1.000															
Grain Elong Ratio, ER	0.004	-0.151	-0.139	0.315*	0.111	0.050	-0.034	1.000														
Satake Whiteness, AW	0.308*	-0.255*	0.462*	-0.171	0.015	0.149	-0.144	-0.144	1.000													
Alkali Spreading 1.7, AS17	0.120	-0.344*	0.401*	-0.358*	0.022	0.355*	-0.054	-0.212	0.038	1.000												
Alkali Spreading 1.5, AS15	0.413*	-0.036	0.397*	-0.479*	0.122	0.108	-0.065	-0.315*	-0.011	0.581*	1.000											
Milled Rice Protein, MRP	0.557*	0.041	0.397*	-0.063	0.356*	0.145	-0.003	-0.066	0.178	0.057	0.343*	1.000										
Milled Rice Lipids, MRL	-0.082	0.052	0.090	-0.191	-0.045	0.184	0.064	-0.329*	-0.319*	0.205	0.364*	0.181	1.000									
Apparent Amylose, AA	-0.374*	0.070	-0.264*	0.365*	-0.017	-0.100	0.259*	-0.005	-0.237*	-0.061	-0.462*	-0.347*	-0.134	1.000								
Soluble Amylose, SA	-0.363*	-0.451*	0.179	0.102	-0.067	0.264*	0.027	-0.021	-0.052	0.403*	-0.011	-0.272*	0.009	0.292*	1.000							
Pasting Temperature, PT	0.041	0.401*	-0.268*	0.131	0.014	-0.492*	0.102	0.067	-0.359*	-0.297*	0.092	0.050	0.167	-0.094	-0.406*	1.000						
Peak Viscosity, PV	0.051	0.286*	-0.135	-0.031	-0.049	-0.225*	-0.086	-0.039	-0.234*	-0.331*	0.226*	0.162	0.277*	-0.287*	-0.377*	0.518*	1.000					
Hot Paste, HP	0.018	0.037	-0.094	0.114	-0.119	-0.232*	-0.142	0.219*	-0.359*	-0.280*	0.121	0.118	0.092	-0.168	-0.233*	0.506*	0.769*	1.000				
Cool Paste, CP	0.036	0.080	-0.141	0.156	-0.061	-0.239*	-0.128	0.281*	-0.417*	-0.285*	0.102	0.122	0.075	-0.158	-0.230*	0.495*	0.721*	0.982*	1.000			
Breakdown, B	-0.095	-0.448*	0.179	0.120	0.022	0.238*	0.001	0.212	0.107	0.309*	-0.235*	-0.169	-0.325*	0.263*	0.455*	-0.446*	-0.886*	-0.437*	-0.385*	1.000		
Setback, S	0.036	-0.312*	0.080	0.266*	0.179	0.094	-0.011	0.443*	-0.134	0.077	-0.207	-0.019	-0.328*	0.151	0.279*	-0.136	-0.524*	0.017	0.103	0.805*	1.000	
Consistency, C	0.083	0.184	-0.209	0.187	0.035	-0.248*	-0.069	0.312*	-0.479*	-0.296*	0.080	0.136	0.072	-0.141	-0.258*	0.502*	0.639*	0.907*	0.964*	-0.328*	0.196	1.000

a Prob > |R| under Ho: Rho=0 / N = 90.

b Refer to Table 3 on page 5 for a description of the respective variables.

c An * denotes statistical significance at the .05 level or lower.

Table 8. Spearman Correlations Among Physicochemical and Sensory Aroma Attributes Used to Determine the Effects of Rough Rice Storage Time and Temperature on Aromatic Rice Quality, Texas A&M Aromatic Rice Project, 1992-93. [a]

Variable [b]	Sw/An Aroma, SWA	Floral Aroma, FLA	Grain Aroma, GRA	Hay-Like Aroma, HYA	Popcorn Aroma, PCA	Corn Aroma, CRA	Alfalfa Aroma, ALA	Dairy Aroma, DRA	Sweet Aroma, STA
2-Acetyl-1-Pyrroline, 2A1P	0.505* [c]	0.390*	0.473*	0.335*	0.473*	0.335*	0.406*	0.345*	0.390*

[a] Prob > |R| under Ho: Rho=0 / N = 7040.

[b] Refer to Table 2 on page 4 and Table 3 on page 5 for a description of the respective variables.

[c] An * denotes statistical significance at the .05 level or lower.

Table 9. Spearman Correlations Among Physicochemical and Flavor Attributes Used to Determine the Effects of Rough Rice Storage Times and Temperatures on Aromatic Rice Quality, Texas A&M Aromatic Rice Project, 1992-93. [a]

Variable [b]	Sw/An Flavor, SAN	Grain Flavor, GRN	Popcorn Flavor, PCN	Floral Flavor, FLR	Dairy Flavor, DRY	Water-like Flavor, WTL	Sweet Flavor, SWT
2-Acetyl-1-Pyrroline, 2A1P	0.417* [c]	0.432*	0.415*	0.394*	0.400*	0.472*	0.504*

[a] Prob > |R| under Ho: Rho=0 / N = 7040.

[b] Refer to Table 2 on page 4 and Table 3 on page 5 for a description of the respective variables.

[c] An * denotes statistical significance at the .05 level or lower.

Table 10. Spearman Correlations Among Sensory Color and Chalk Attributes and Physicochemical Color Measurements Used to Determine the Effects of Rough Rice Storage Time and Temperature on Aromatic Rice Quality, Texas A&M Aromatic Rice Project, 1992-93. [a]

Variable [b]	RR	AW	CK
Raw Rice Color, RR	1.000		
Satake Whiteness, AW	0.241* [c]	1.000	
% Chalky Kernels, CK	0.050*	0.228*	1.000

[a] Prob > |R| under Ho: Rho=0 / N = 3680.

[b] Refer to Table 1 on page 3 and Table 3 on page 5 for a description of the respective variables.

[c] An * denotes statistical significance at the .05 level or lower.

Table 11. Spearman Correlations Among Sensory Texture and Selected Physicochemical Attributes Used to Determine the Effects of Rough Rice Storage Time and Temperature on Aromatic Rice Quality, Texas A&M Aromatic Rice Project, 1992-93. [a]

	Variable [b]	Sensory Texture Variables										
		Adhesive, AD	Chewiness, CH	Cohesive, CO	Unif of Bite, UB	Hardness, HA	Tthpcking, TO	CohofMass, CM	Star Ctng, SC	Surf Slick, SS	Roughness, RO	Residuals, RE
Physiochemical	% Chalky Kernels, CK	-0.123*[c]	0.092*	0.010	0.265*	0.023*	0.204*	0.064*	-0.065*	0.119*	0.201*	0.383*
	Satake Whiteness, AW	-0.002	0.173*	0.249*	0.222*	-0.035*	0.341*	0.211*	0.127*	0.085*	0.195*	0.425*
	Alkali Spreading 1.7, AS17	0.072*	-0.193*	-0.106*	0.195*	-0.101*	0.189*	0.100*	-0.041*	0.118*	0.182*	0.290*
	Alkali Spreading 1.5, AS15	0.274*	-0.157*	-0.099*	-0.161*	-0.191*	-0.087*	-0.020	0.005	0.030*	-0.080*	-0.051*
	Milled Rice Protein, MRP	0.030*	0.124*	0.172*	-0.115*	0.018	-0.105*	-0.092*	-0.026*	0.003	-0.004	-0.036*
	Milled Rice Lipids, MRL	0.105*	0.082*	-0.150*	-0.074*	-0.052*	-0.047*	0.037*	0.025*	0.152*	-0.202*	-0.139*
	Apparent Amylose, AA	-0.114*	-0.091*	-0.115*	0.158*	0.058*	0.113*	0.049*	-0.018	0.007	0.080*	0.104*
	Soluble Amylose, SA	-0.156*	-0.113*	-0.064*	0.248*	0.063*	0.271*	0.129*	-0.007	0.162*	0.275*	0.405*
	2-Acetyl-1-Pyrroline, 2A1P	0.124*	0.110*	0.158*	0.374*	-0.026*	0.597*	0.519*	0.292*	0.444*	0.244*	0.581*

[a] Prob > |R| under Ho: Rho=0 / N = 82.

[b] Refer to Table 1 on page 3 and Table 3 on page 5 for a description of the respective variables.

[c] An * denotes a statistical significance at the .05 level or lower.

Table 12. Spearman Correlations Among Sensory Texture and Physicochemical Rapid Viscosity Analysis (RVA) Attributes Used to Determine the Effects of Rough Rice Storage Time and Temperature on Aromatic Rice Quality, Texas A&M Aromatic Rice Project, 1992-93. [a]

Variable [b]		Sensory Texture Variables										
		Adhesive, AD	Chewiness, CH	Cohesive, CO	Unif of Bite, UB	Hardness, HA	Tthpcking, TO	Coh of Mass, CM	Star Ctng, SC	SurfSlick, SS	Roughness, RO	Residuals, RE
Physicochemical RVA	Pasting Temp, PT	0.160*[c]	-0.092*	-0.147*	-0.309*	-0.120*	-0.376*	-0.248*	-0.005	-0.189*	-0.334*	-0.554*
	Peak Viscosity, PV	0.094*	-0.126*	-0.233*	-0.454*	-0.090*	-0.509*	-0.354*	-0.194*	-0.289*	-0.324*	-0.570*
	Hot Paste, HP	-0.082*	-0.274*	-0.346*	-0.427*	-0.008	-0.640*	-0.630*	-0.365*	-0.493*	-0.156*	-0.558*
	Cool Paste, CP	-0.119*	-0.256*	-0.334*	-0.456*	0.040*	-0.654*	-0.647*	-0.374*	-0.480*	-0.133*	-0.573*
	Breakdown, B	-0.223*	0.016	0.135*	0.345*	0.122*	0.292*	0.073*	-0.006	0.067*	0.363*	0.462*
	Setback, S	-0.350*	-0.018	0.052*	0.038*	0.160*	-0.072*	-0.266*	-0.217*	-0.169*	0.232*	0.153*
	Consistency, C	-0.138*	-0.203*	-0.310*	-0.475*	0.093*	-0.650*	-0.631*	-0.351*	-0.450*	-0.125*	-0.586*

[a] Prob > |R| under Ho: Rho=0 / N = 82.

[b] Refer to Table 1 on page 3 and Table 3 on page 5 for a description of the respective variables.

[c] An * denotes a statistical significance at the .05 level or lower.

Table 13. Spearman Correlations Among Sensory Texture and Physicochemical Grain Size Attributes Used to Determine the Effects of Rough Rice Storage Time and Temperature on Aromatic Rice Quality, Texas A&M Aromatic Rice Project, 1992-93. [a]

	Variable [b]	Sensory Texture Variables										
		Adhesive, AD	Chewiness, CH	Cohesive, CO	Unif of Bite, UB	Hardness, HA	Tthpcking, TO	Coh of Mass, CM	Star Ctng, SC	Surf Slick, SS	Roughness, RO	Residuals, RE
Physicochemical Grain Size	Grain Length, GL	-0.105*[c]	0.156*	0.131*	-0.175*	-0.018	-0.068*	-0.079*	-0.191*	-0.082*	0.167*	0.049*
	Grain Width, GW	0.199*	0.145*	0.051*	-0.229*	-0.068*	-0.054*	0.138*	0.157*	0.106*	-0.261*	-0.337*
	Length/Width, Ratio LWR	-0.094*	-0.010	0.050*	0.083*	-0.016	0.077*	-0.046*	-0.147*	-0.061*	0.246*	0.312*
	Grain Thickness, GT	-0.196*	-0.002	0.085*	0.039*	-0.029*	-0.089*	-0.140*	0.016	0.002	-0.132*	-0.112*
	Grain Weight, GWT	-0.022	0.263*	0.287*	-0.078*	0.054*	0.097*	0.135*	0.019	0.181*	0.039*	0.135*
	Min Cooking Time, MCT	-0.014	0.146*	0.123*	-0.048*	-0.029*	0.174*	0.151*	0.058*	0.121*	-0.048*	0.094*
	Grain Elong Ratio, ER	-0.376*	-0.046*	0.004	-0.023	0.122*	-0.330*	-0.383*	-0.173*	-0.229*	0.038*	-0.174*

[a] Prob > |R| under Ho: Rho=0 / N = 82.

[b] Refer to Table 1 on page 3 and Table 3 on page 5 for a description of the respective variables.

[c] An * denotes a statistical significance at the .05 level or lower.

Table 14. Spearman Correlations Among Textureometer Attributes Used to Determine the Effects of Rough Rice Storage Time and Temperature on Aromatic Rice Quality, Texas A&M Aromatic Rice Project, 1992-3. [a]

Variable [b]	MAD	MCH	MCO	MGU	MHA	MSP	MMD
Adhesiveness, MAD	1.000						
Chewiness, MCH	-0.717* [c]	1.000					
Cohesiveness, MCO	-0.617*	0.821*	1.000				
Gumminess, MGU	-0.671*	0.868*	0.892*	1.000			
Hardness, MHA	-0.626*	0.795*	0.742*	0.955*	1.000		
Springiness, MSP	-0.532*	0.697*	0.370*	0.317*	0.237*	1.000	
Resistance, MMD	-0.118	0.284*	0.006	0.130	0.219	0.438*	1.000

[a] Prob > |R| under Ho: Rho=0 / N =172.

[b] Refer to Table 4 on page 6 for a description of the respective variables.

[c] An * denotes a statistical significance at the .05 level or lower.

Table 15. Spearman Correlations Among Textureometer and Physicochemical Grain Size Attributes Used to Determine the Effects of Rough Rice Storage Time and Temperature on Aromatic Rice Quality, Texas A&M Aromatic Rice Project, 1992-3. [a]

Variable [b]		Textureometer Variables						
		Adhesiveness, MAD	Chewiness, MCH	Cohesiveness, MCO	Gummimess, MGU	Hardness, MHA	Springiness, MSP	Resistance, MMD
Physicochemical	Grain Size	Grain Length, GL	0.292* [c]	-0.148	-0.156*	-0.070	-0.022	-0.180*	0.093
		Grain Width, GW	-0.245*	0.032	0.059	0.114	0.158*	-0.134	-0.078
		Length/Width Ratio, LWR	0.259*	-0.074	-0.045	-0.045	-0.054	-0.072	0.036
		Grain Thickness, GT	-0.263*	0.218*	0.088	0.131	0.168*	0.215*	0.213*
		Grain Weight, GWT	-0.147	0.002	-0.027	-0.002	0.057	0.001	0.043
		Min Cooking Time, MCT	-0.255*	0.113	0.066	0.123	0.163*	0.018	0.103
		Grain Elong Ratio, ER	0.246*	-0.013	-0.187*	-0.148	-0.100	0.210*	0.403*

[a] Prob > |R| under Ho: Rho=0 / N = 172.

[b] Refer to Table 3 on page 5 and Table 4 on page 6 for a description of the respective variables.

[c] An * denotes a statistical significance at the .05 level or lower.

Table 16. Spearman Correlations Among Sensory Texture and Textureometer Attributes Used to Determine the Effects of Rough Rice Storage Time and Temperature on Aromatic Rice Quality, Texas A&M Aromatic Rice Project, 1992-3. [a]

Variable [b]		Sensory Texture Variables										
		Adhesive, AD	Chewiness, CH	Cohesive, CO	Unif of Bite, UB	Hardness, HA	Tthpcking, TO	Coh of Mass, CM	Star Ctng, SC	Surf Slick, SS	Roughness, RO	Residuals, RE
Textureometer	Adhesiveness, MAD	-0.024	-0.248* [c]	-0.199*	-0.152	-0.062	-0.468*	-0.397*	-0.368*	-0.458*	-0.139	-0.287*
	Chewiness, MCH	-0.132	0.205*	0.137	0.108	0.104	0.308*	0.162*	0.204*	0.211*	0.221*	0.234*
	Cohesiveness, MCO	0.010	0.273*	0.194*	0.198*	0.100	0.454*	0.359*	0.292*	0.307*	0.236*	0.356*
	Gumminess, MGU	-0.060	0.307*	0.141	0.109	0.094	0.361*	0.271*	0.189*	0.226*	0.282*	0.264*
	Hardness, MHA	-0.121	0.334*	0.109	0.066	0.107	0.267*	0.199*	0.093	0.156*	0.312*	0.199*
	Springiness, MSP	-0.187*	-0.076	0.017	0.093	0.019	0.067	-0.079	0.146	0.130	0.001	0.048
	Resistance, MMD	-0.389*	0.001	-0.148	-0.065	0.055	-0.236*	-0.346*	-0.240*	-0.112	0.132	-0.143

[a] Prob > |R| under Ho: Rho=0 / N = 160.

[b] Refer to Table 1 on page 3 and Table 4 on page 6 for a description of the respective variables.

[c] An * denotes a statistical significance at the .05 level or lower.

Table 17. Spearman Correlations Among Textureometer and Selected Physicochemical Attributes Used to Determine the Effects of Rough Rice Storage Time and Temperature on Aromatic Rice Quality, Texas A&M Aromatic Rice Project, 1992-3. [a]

	Variable [b]	Textureometer Variables						
		Adhesiveness, MAD	Chewiness, MCH	Cohesiveness, MCO	Gumminess, MGU	Hardness, MHA	Springiness, MSP	Resistance, MMD
Physicochemical	% Chalky Kernels, CK	0.030	0.021	0.122* [c]	0.024	-0.024	0.044	0.108
	Satake Whiteness, AW	-0.051	0.179*	0.315*	0.217*	0.116*	0.023	-0.261*
	Alkali Speading 1.7, AS17	0.094	-0.153*	-0.101	-0.168*	-0.206*	-0.022	-0.072
	Alkali Spreading 1.5, AS15	0.235*	-0.306*	-0.318*	-0.287*	-0.260*	-0.161*	-0.060
	Milled Rice Protein, MRP	0.084	-0.057	-0.140*	-0.057	0.011	-0.083	0.146*
	Milled Rice Lipids, MRL	-0.112*	-0.113*	-0.150*	-0.089	-0.033	-0.116*	0.039
	Apparent Amylose, AA	-0.285*	0.179*	0.121*	0.107	0.107	0.218*	0.051
	Soluble Amylose, SA	-0.183*	0.094	0.089	0.046	0.009	0.182*	0.070
	2-Acetyl-1-Pyrroline, 2A1P	-0.388*	0.244*	0.413*	0.287*	0.160*	0.094	-0.214*

[a] Prob > |R| under Ho: Rho=0 / N = 328.

[b] Refer to Table 3 on page 5 and Table 4 on page 6 for a description of the respective variables.

[c] An * denotes a statistical significance at the .05 level or lower.

Table 18. Spearman Correlations Among Textureometer and Physicochemical Rapid Viscosity Analysis (RVA) Attributes Used to Determine the Effects of Rough Rice Storage Time and Temperature on Aromatic Rice Quality, Texas A&M Aromatic Rice Project, 1992-3. [a]

Variable [b]		Textureometer Variables						
		Adhesiveness, MAD	Chewiness, MCH	Cohesiveness, MCO	Gumminess, MGU	Hardness, MHA	Springiness, MSP	Resistance, MMD
Physicochemical RVA	Pasting Temp, PT	0.066	-0.049	-0.222* [c]	-0.027	0.091	-0.124	0.141
	Peak Viscosity, PV	0.301*	-0.261*	-0.333*	-0.233*	-0.149	-0.181*	0.101
	Hot Paste, HP	0.510*	-0.262*	-0.425*	-0.278	-0.169*	-0.111	0.323*
	Cool Paste, CP	0.494*	-0.241*	-0.422*	-0.265*	-0.151*	-0.085	0.372*
	Breakdown, B	-0.052	0.173*	0.164*	0.122	0.084	0.171*	0.075
	Setback, S	0.225*	0.000	-0.118	-0.075	-0.041	0.115	0.265*
	Consistency, C	0.466*	-0.225*	-0.411*	-0.249*	-0.129	-0.075	0.399*

[a] Prob > |R| under Ho: Rho=0 / N = 837.

[b] Refer to Table 3 on page 5 and Table 4 on page 6 for a description of the respective variables.

[c] An * denotes a statistical significance at the .05 level or lower.