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RELATIONSHIP BETWEEN PHYSICAL AND CHEMICAL CHARACTERISTICS OF VEGETABLE TANNED SOLE LEATHERS OF INDIAN ORIGIN

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Summary

The relationship between some of the chemical characteristics and important physical characteristics of vegetable tanned Indian buffalo hides is studied. Samples from both the butt and back regions are taken up for the studies to arrive at definite conclusions. Systematic analysis of the data obtained are carried out and then correlations are illustrated through graphs.

The tanner is interested to produce leathers that could be easily saleable without any difficulty. Towards this end he has to ensure that the ultimate leather is of best quality. Almost all the National Standards specifications for different types of leather have stipulated the requirements in respect of both the physical and chemical characteristics depending on the ultimate uses to which such leathers are put. In order to obtain standard leathers the tanner makes adjustments in the processing and applies various aspects of quality controls during the production proper, taking into account the nature of water supplies, raw hide/skin and auxiliary chemicals as well as climatic conditions. By judicious handling of the hide/skin and use of optimum amount of chemicals, he is able to get leathers of his choice. In view of the multifarious factors in the production of different types of leathers, for that matter even in the case of particular type of leather, it has become obligatory on the part of the tanner to ensure batch-to-batch controls/adjustments to obtain uniform and standard quality leathers. As much information as possible on the effect of particular unit process over the physical and chemical characteristics of final leathers, as well as interdependence of physical and chemical characteristics are necessary to orient the production schedule in the desired direction. Ever since the technology started developing, efforts to find the correlations between physical and chemical properties have been attempted. Most of the existing findings have been arrived at on the basis of continental hides and skins. The unique qualities of Indian buffalo hides as compared to those of animals of other countries have already been established.[1] In India, these buffalo hides are put into varied uses shoe soles to industrial beltings—and thus occupy an important source of raw material for the Indian leather industry. In view of the importance of this type of buffalo leather and the need to have better understanding of the relationship among their physical and chemical characteristics, systematic studies are conducted on Indian buffalo hides.

Experimental

Seventy-two hides were taken up for the studies, vegetable tanned,[2] and samples from both the butt (240 mm from the back bone) and back (120 mm from the backbone) regions of right and left sides from the individual leathers—144 samples each of butts and backs were obtained. The samples were then subjected to physical testing and chemical analysis.[3] The physical characteristics taken up for the present studies were tensile strength, tearing strength and percentage water absorption (Kubelka) in 24 h and the chemical characteristics, percentage oils and fats (petroleum ether solubles), percentage water solubles, percentage fixed tannins, percentage leather substance (all on 14% moisture basis) and degree of tannage. The data in respect of each chemical characteristic were then arranged in increasing order and grouped into 12 sets of 12 butts each. The averages of chemical characteristics of each set and their corresponding physical characteristics were then worked out. The data obtained are given in Table I. Similarly the data for backs are given in Table II. Using this data, graphs of each of five chemical characteristics against all of the three physical characteristics are drawn in respect of butts, Figs. 1–5 and backs Figs. 6–10.

Discussion

(i) (a) *Oils and Fats—Tensile Strength and Tearing Strength* (Fig. 1)

The strength properties were found to be directly proportional to the extent of grease content of the leathers, as the fibres are better lubricated, offering greater resistance to pulling. This is in agreement with the findings on other types of leathers as well.[4-7] Absence of any relationship between oils and fats to strength properties are also reported in certain cases.[8-10]

(b) *Oils and fats—Water absorption* (Fig. 1)

The increase in the grease content tends to lower the water absorption thereby showing increased resistance to water. The same trend is also observed in the case of English sole leathers,[7] and other types of leathers.[4,11,12]

(ii) (a) *Water Solubles—Tensile Strength and Tearing Strength* (Fig. 2)

Greater amount of water soluble matter was found to decrease the strength properties of the leathers under examination. This is in line with the earlier work[13] as well. Water solubles constitute unfixed organic and inorganic matter and do not contribute to the strength of the leather.

TABLE I

Butt—Correlation Between Chemical and Physical Characteristics

Characteristics	1	2	3	4	5	6	7	8	9	10	11	12
I. Oils and fats (%)	1·62	1·78	2·01	2·22	2·40	2·62	2·79	3·01	3·21	3·40	3·58	3·80
A. Tensile strength	297·5	299·6	300·6	304·5	310·4	309·5	313·7	313·0	315·1	316·2	320·2	324·00
B. Tearing strength	57·2	58·5	59·9	62·6	63·3	62·3	63·5	69·5	70·6	71·5	72·9	75·3
C. Water absorption (Kubelka) in 24 h	58·8	57·4	56·6	54·4	55·5	54·0	54·0	51·4	49·7	50·3	47·6	47·4
II. Water solubles (%)	8·75	9·23	9·77	10·26	11·0	12·01	12·26	12·78	13·30	14·25	14·74	15·15
A. Tensile strength	333·5	328·0	327·0	324·3	315·9	306·4	307·2	300·1	297·5	292·8	291·7	282·0
B. Tearing strength	80·6	77·9	79·1	74·[illegible]	73·0	71·0	68·9	64·9	65·7	62·3	62·2	57·5
C. Water absorption (Kubelka) in 24 h	52·3	51·2	53·7	54·6	56·3	57·6	58·2	58·8	57·01	59·25	59·75	50·25
III. Fixed tannins (%)	23·29	23·71	24·26	24·[illegible]	25·19	25·72	26·17	26·53	26·8[illegible]	27·25	27·69	28·30
A. Tensile strength	295·21	297·5	306·1	311·[illegible]	314·8	323·5	333·6	322·4	327·[illegible]	332·0	338·0	340·5
B. Tearing strength	56·9	57·3	61·0	68·[illegible]	71·2	74·5	78·5	78·2	84·[illegible]	84·4	83·1	82·43
C. Water absorption (Kubelka) in 24 h	59·8	59·3	58·2	57·[illegible]	54·6	54·1	54·3	53·0	54·[illegible]	52·4	51·6	50·9
IV. Leather substance (%)	67·55	68·0	68·50	69·[illegible]	70·04	70·56	70·98	71·75	72·6[illegible]	72·57	73·06	74·08
A. Tensile strength	314·2	314·3	315·0	314·[illegible]	318·9	320·2	322·5	323·5	324·2	325·8	327·5	328·5
B. Tearing strength	61·3	63·50	63·3	65·0	66·1	67·5	67·0	68·5	69·8	70·6	71·8	73·0
C. Water absorption (Kubelka) in 24 h	57·3	56·0	56·7	55·1	53·5	52·3	51·8	51·3	50·2	50·3	50·0	49·25
V. Degree of tannage	52·52	53·70	54·73	55·87	56·93	58·10	59·13	60·41	60·80	61·44	62·77	63·74
A. Tensile strength	295·2	297·5	306·1	311·2	314·8	323·5	333·6	327·5	328·20	332·0	338·0	340·5
B. Tearing strength	56·9	57·3	61·0	68·6	71·2	74·5	78·6	81·1	84·1	83·0	83·8	84·3
C. Water absorption (Kubelka) in 24 h	59·8	59·3	58·2	57·2	54·6	54·3	54·0	52·8	51·8	51·6	50·9	50·4

Units: A = kg/cm²; B = kg/cm thickness; C = percentage.

TABLE II

Back—Correlation Between Chemical and Physical Characteristics

Characteristics	1	2	3	4	5	6	7	8	9	10	11	12
I. Oils and fats (%)	1·52	2·19	2·51	2·92	3·25	3·67	3·76	4·02	4·78	4·95	5·46	6·10
A. Tensile strength	360·90	420·0	427·2	432·0	444·8	444·8	445·4	470·0	491·5	508·3	519·5	545·8
B. Tearing strength	50·50	60·8	59·0	63·4	67·1	67·1	67·1	74·6	79·8	78·9	79·4	84·1
C. Water absorption (Kubelka) in 24 h	54·90	53·0	51·8	50·8	50·6	50·4	49·0	49·4	44·6	45·4	44·2	45·3
II. Water solubles (%)	8·28	8·95	9·27	9·75	10·24	10·77	11·24	11·92	12·35	12·78	13·26	14·14
A. Tensile strength	460·8	460·2	458·0	446·0	451·0	430·0	414·3	419·0	419·0	406·3	380·7	380·1
B. Tearing strength	69·15	67·8	67·3	67·2	66·6	65·80	64·70	62·90	64·0	63·00	62·8	61·2
C. Water absorption (Kubelka) in 24 h	48·3	49·2	48·9	49·8	50·6	51·0	51·80	52·0	52·5	52·70	53·2	55·8
III. Fixed tannins (%)	22·22	23·73	24·28	24·81	25·30	25·79	26·34	26·67	27·08	29·75	29·97	30·35
A. Tensile strength	372·8	402·3	420·3	400·6	408·2	410·6	434·2	440·2	438·0	480·0	480·6	495·5
B. Tearing strength	46·5	52·0	51·8	56·7	60·8	62·0	62·6	65·8	65·9	72·4	72·3	75·8
C. Water absorption (Kubelka) in 24 h	55·2	52·6	51·2	49·8	49·9	50·1	49·2	49·5	49·0	45·5	45·2	45·0
IV. Leather substance (%)	66·25	67·55	68·26	68·48	69·24	69·55	69·76	70·20	70·55	71·03	71·96	73·01
A. Tensile strength	432·2	433·4	435·8	435·0	440·6	443·2	442·7	455·3	448·9	452·2	454·5	459·0
B. Tearing strength	63·00	63·5	64·02	63·49	64·8	65·50	64·8	65·10	65·8	66·49	67·90	67·58
C. Water absorption (Kubelka) in 24 h	56·4	55·1	54·60	54·8	54·3	54·0	54·5	54·0	54·0	53·5	53·20	52·2
V. Degree of tannage	57·83	59·10	60·91	61·56	63·41	65·98	68·85	69·46	69·65	70·18	70·48	71·03
A. Tensile strength	370·3	390·6	400·1	405·0	420·1	434·4	459·8	412·3	486·0	485·3	484·3	480·3
B. Tearing strength	52·2	57·3	61·6	61·7	61·9	66·0	70·3	71·0	71·85	71·5	71·3	73·05
C. Water absorption (Kubelka) in 24 h	55·3	54·3	52·5	52·5	52·5	49·4	46·50	46·30	45·60	45·4	45·3	45·1

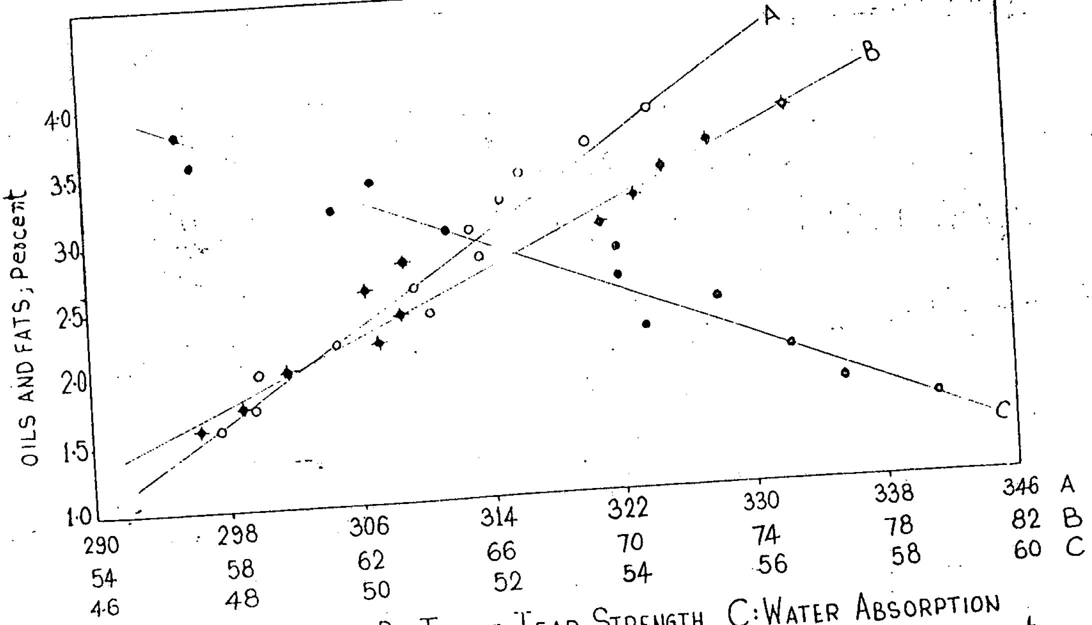
Units: A = kg/cm²; B = kg/cm thickness; C = percentage.

(b) *Water Solubles—Water Absorption* (Fig. 2)

The presence of water solubles was found to promote the water absorption thereby reducing the resistance of the leather to water. The loosely held water soluble matter in excessive amounts comes out of the interstices of the leather fibres as the leather remains in contact with water resulting in the uptake of water in their place. The fact that the extent of water absorption depends on the free space available in the leather[14-16] and can be altered by incorporation of filling agents inclusive of water solubles, as well as by physical measure by rolling *etc.*, deserves mention while studying this correlation. Weber[17] has shown that the water-proofness increases with the water solubles up to a certain limit and that water absorption power and water proofness depend on the structure of the leather and the type of tanning.

(iii) (a) *Fixed Tannins—Tensile Strength and Tearing Strength* (Fig. 3)

Fixed organic matter in the leather contributes to greater strength properties. This finding is in consonance with that of Sasaki *et al.*[18] Herfeld and Stather[19] have



KEY FOR ALL THE FIGURES: A: TENSILE STRENGTH (Kg/Sq.cm) B: TONGUE TEAR STRENGTH (Kg/cm.thickness) C: WATER ABSORPTION (Kubelka) in 24 Hrs, Percent.

FIGURE 1. Butt: oils and fats (per cent) vs physical characteristics

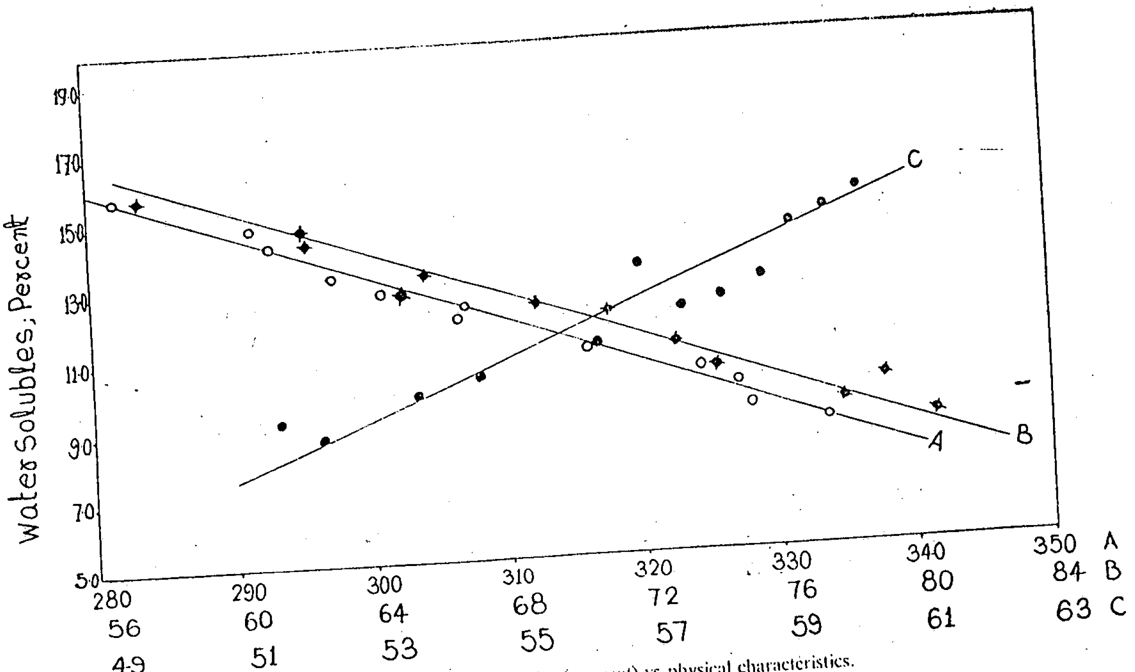


FIGURE 2. Butt: water solubles (per cent) vs physical characteristics.

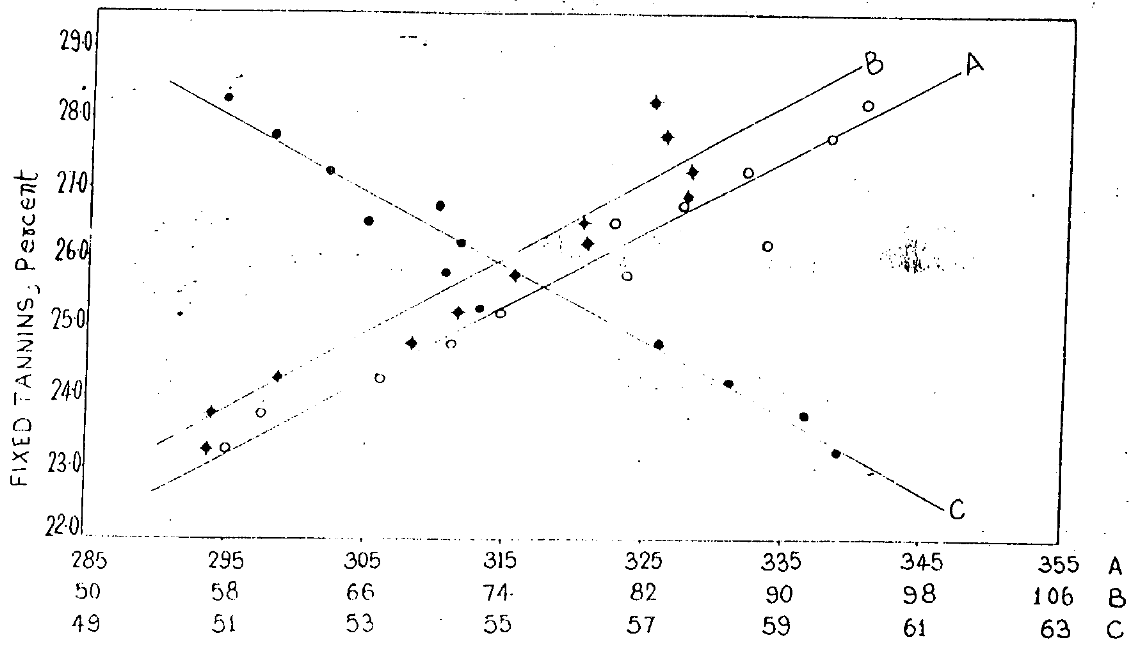


FIGURE 3. Butt: fixed tannins (per cent) vs physical characteristics.

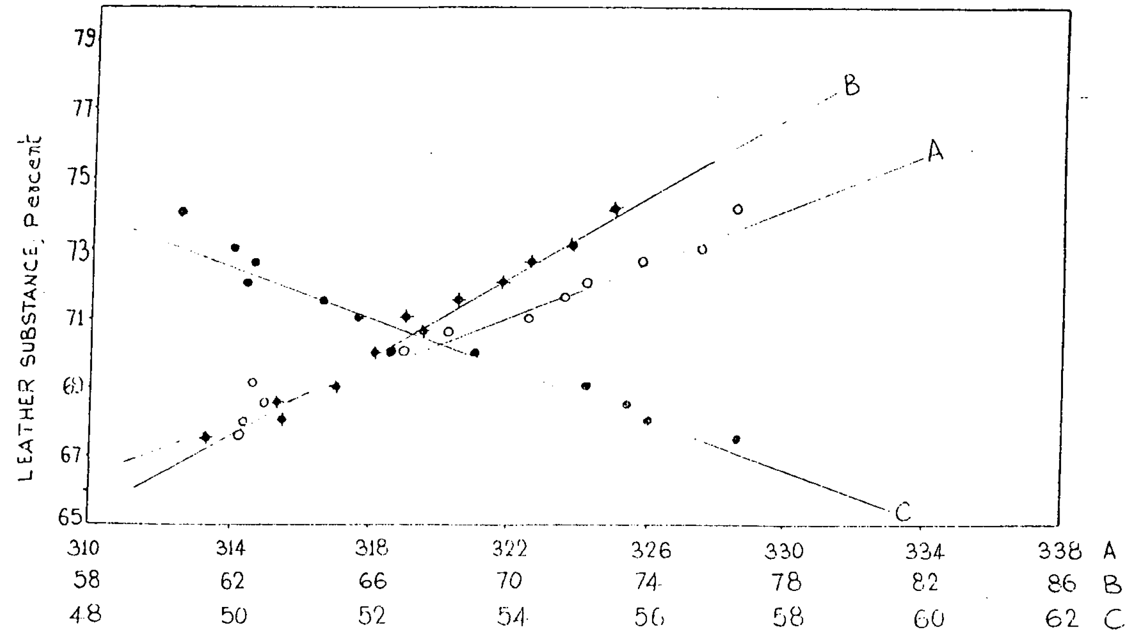


FIGURE 4. Butt: leather substance (per cent) vs physical characteristics.

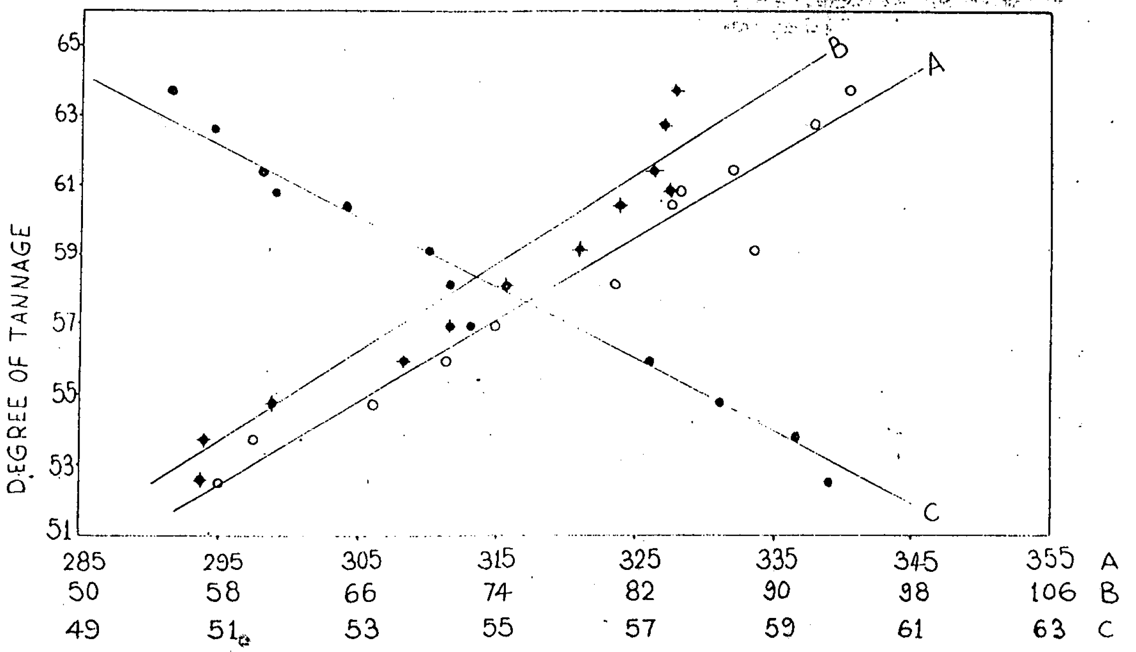


FIGURE 5. Butt: degree of tannage vs physical characteristics.

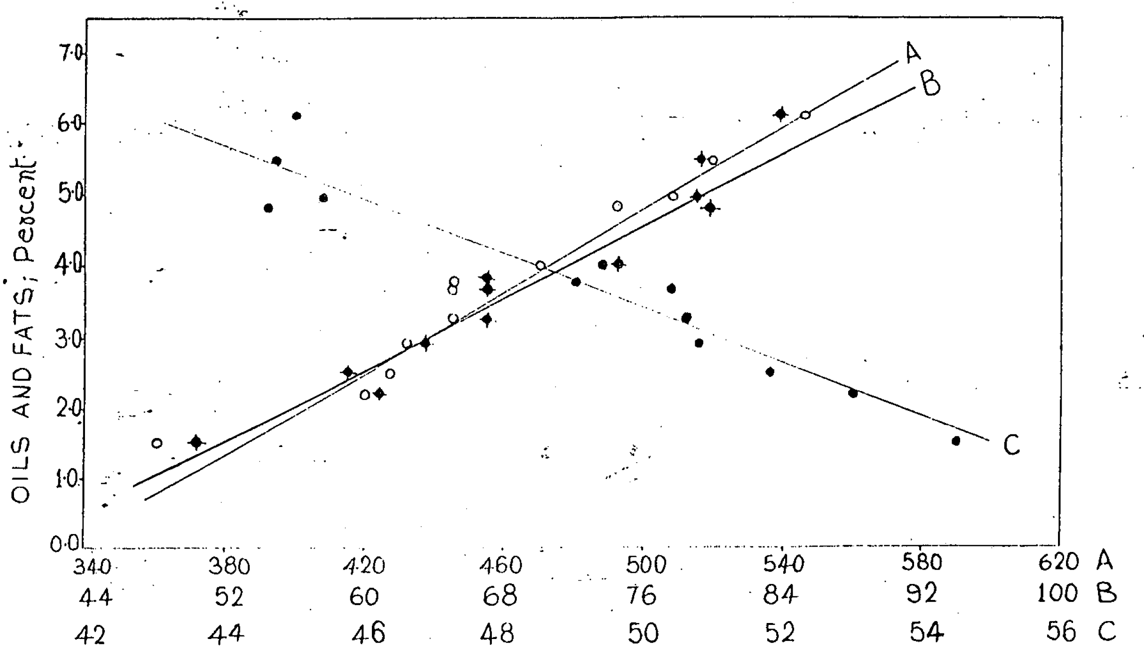


FIGURE 6. Back: oils and fats (per cent) vs physical characteristics.

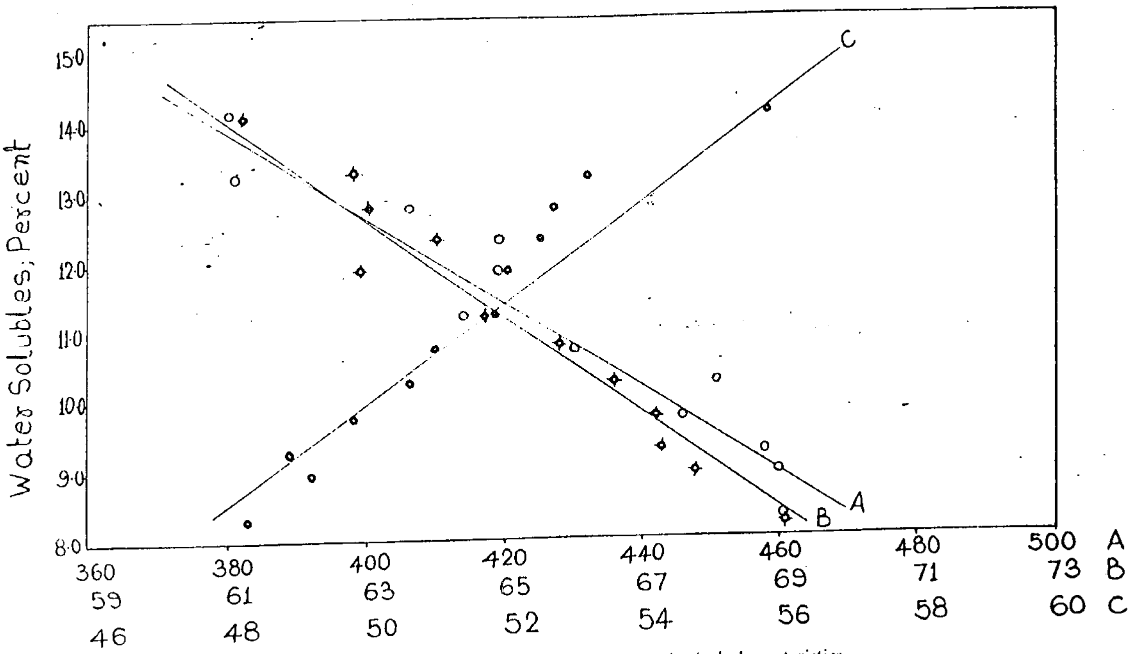


FIGURE 7. Back: water solubles (per cent) vs physical characteristics.

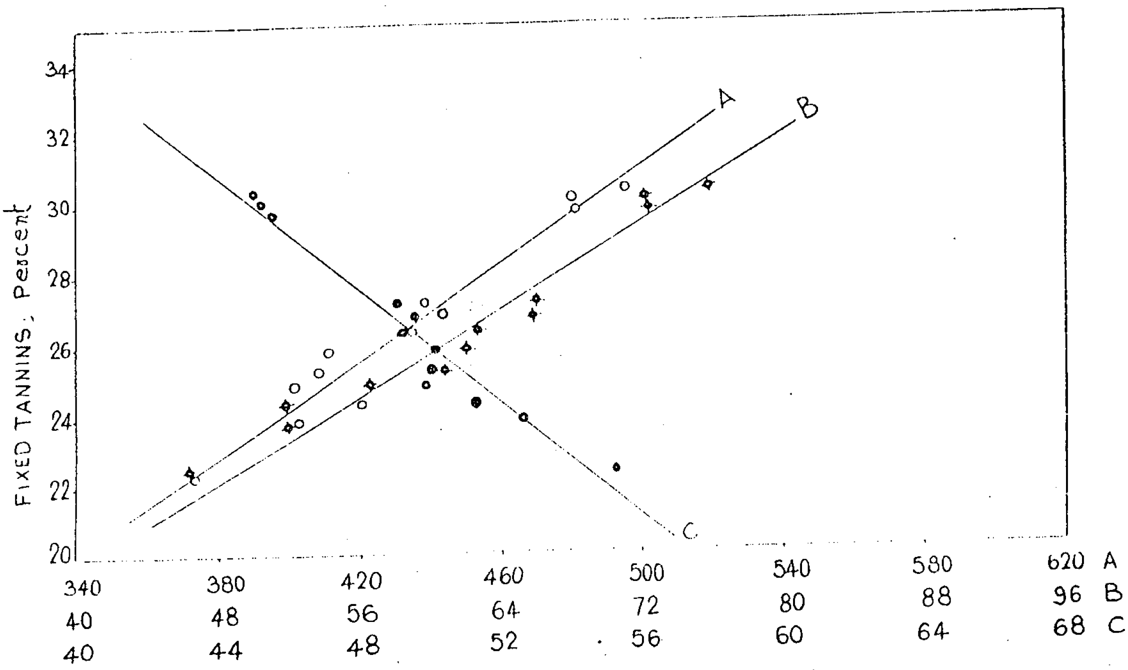


FIGURE 8. Back: fixed tannins (per cent) vs physical characteristics.

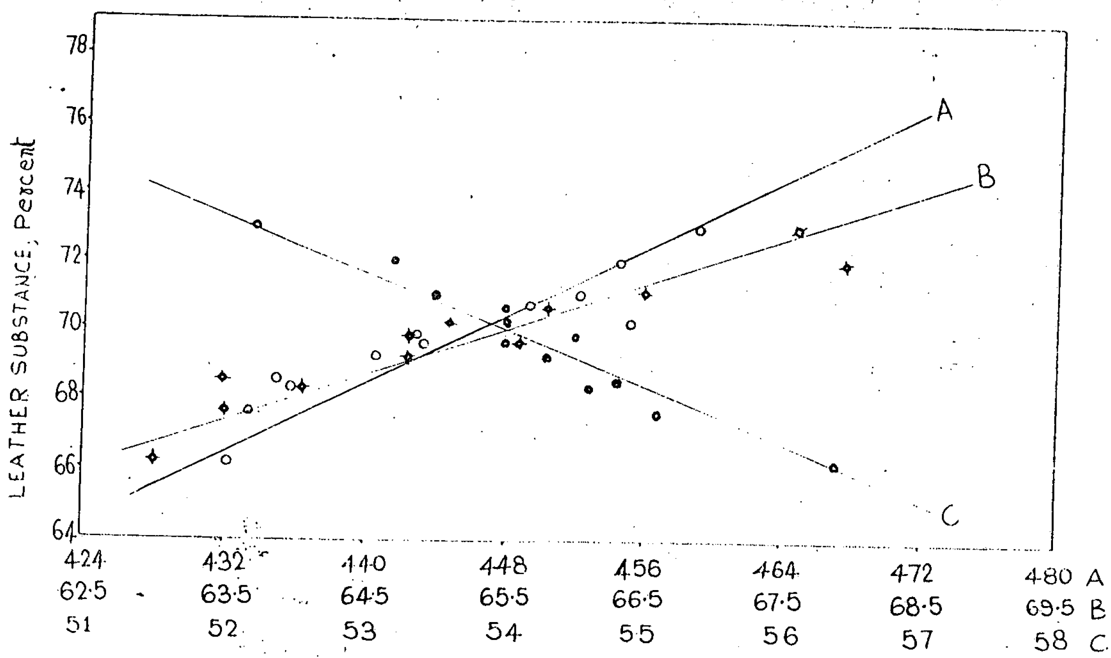


FIGURE 9. Back: leather substance (per cent) vs physical characteristics.

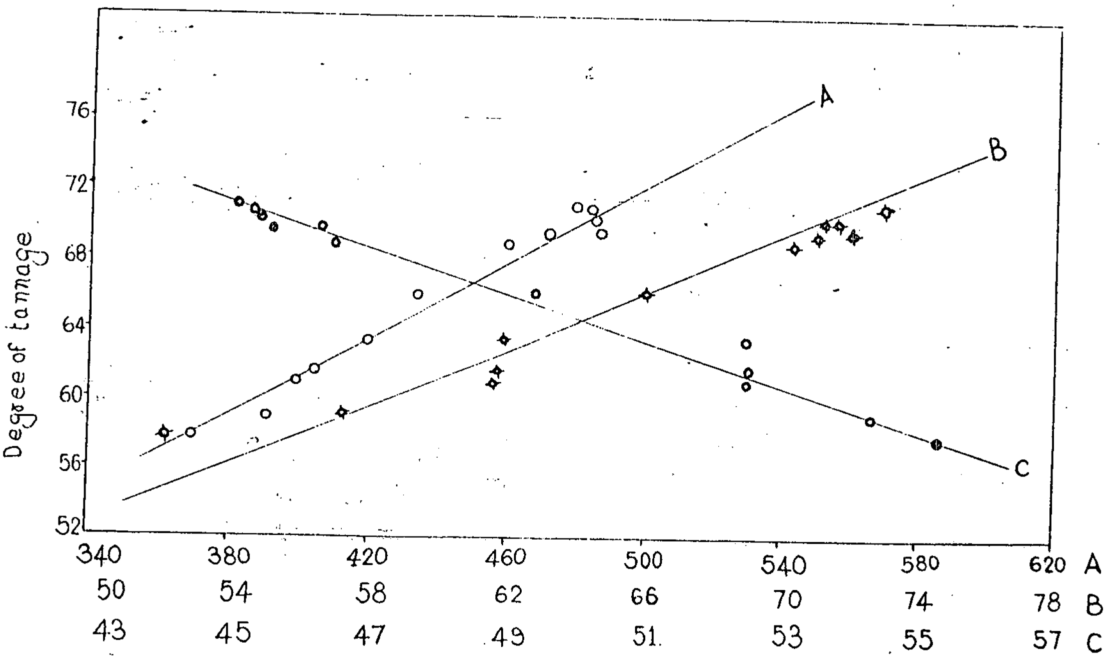


FIGURE 10. Back: degree of tannage vs physical characteristics.

however reported decrease in strength properties with increase in the combined fixation of tannins and chrome.

(b) *Fixed Tannins—Water Absorption* (Fig. 3)

Fixed tannins bear indirect proportion with water absorption in contrast to the correlation between unfixed water solubles and water absorption. Fixed tannins are responsible for the real tannage and hence their influence towards resistance to water. Herfeld's[19] studies also indicate water absorption declining with the increasing tannin contents for vegetable tanned leathers.

(iv) (a) *Leather Substance—Tensile Strength and Tearing Strength* (Fig. 4)

As is the case with the fixed tannins that go to make the real leather, leather substance bears direct proportion to the strength properties.

(b) *Leather Substance—Water Absorption* (Fig. 4)

Here again the trend is the same as the relationship between fixed tannins and water absorption. With the increase in the content of leather substance, the resistance to water increases.

(v) (a) *Degree of Tannage—Tensile Strength and Tearing Strength* (Fig. 5)

As can be expected, within the usual range of inputs of tanning agents, the resultant degree of tannage in optimal limits increases the strength of the leathers.

(b) *Degree of Tannage—Water Absorption* (Fig. 5)

By the same analogy, degree of tannage can be said to increase the resistance of the leather to water as well. McKay[20] has also proved the tendency of reduced water absorption with the increase in degree of tannage.

All the observations made above are in respect of butts. Similar are the trends with the backs as well and the same are illustrated in Figs. 6–10.

Conclusion

Vegetable tanned Indian buffalo hides are found to exhibit definite correlations among their physical and chemical characteristics. While the oils and fats, fixed tannins, leather substance and degree of tannage are directly proportional to the tensile strength and tearing strength, they are indirectly proportional to water absorption. The trend is exactly opposite in the case of water solubles against tensile strength, tearing strength and water absorption. The tanner may do well to employ the optimal inputs of greasy matter and tanning matter and adopt suitable adjustments in the technological processes towards a reduced amount of water solubles and optimal fixation of tannins for obtaining leathers with better strengths and better resistance to water.

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