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AMKFC REPORT 4-63

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A MEASURE OF THE QUALITY AND ACCEPTANCE OF BEEF LIVER

1. An Objective Method of Determining the Quality of Beef Liver
2. The Influence of Color and Conformation upon the Acceptance of Beef Liver

Interim Report

MEAT PRODUCTS BRANCH, FOOD DIVISION

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August 1963



ARMED FORCES FOOD AND CONTAINER INSTITUTE  
U.S. ARMY QUARTERMASTER RESEARCH AND ENGINEERING CENTER  
CHICAGO 9, ILLINOIS

<p>AD _____ Accession No. _____  Armed Forces Food And Container Institute,  U. S. Army Quartermaster Research And Engineering Center, Chicago 9, AMXFC Rpt No. <u>4-63</u>  Date <u>Aug. 1963</u> Proj. No. _____  PP <u>17</u> tbl <u>2</u> fig. <u>4</u>  A Measure of the Quality and Acceptance of Beef Liver. by A.L. Savich, W.H. Surges, &amp; D.R. Bellis</p> <p>Two studies indicate that the grading of beef livers can be performed objectively by means of the ratio between two height</p> <p>Primary Field: <u>Quality and Measurement</u>  Secondary Field(s): <u>Beef Liver</u></p>	<p>UNCLASSIFIED</p> <p>1. Liver, Beef.  Acceptability  I. Savich, A.L.  II. Surges, W.H.  III. Bellis, D.R.</p>	<p>UNCLASSIFIED</p> <p>AD _____ Accession No. _____  Armed Forces Food And Container Institute,  U. S. Army Quartermaster Research And Engineering Center, Chicago 9, AMXFC Rpt No. <u>4-63</u>  Date <u>Aug. 1963</u> Proj. No. _____  PP <u>17</u> tbl <u>2</u> fig. <u>4</u>  A Measure of the Quality and Acceptance of Beef Liver. by A.L. Savich, W.H. Surges, &amp; D.R. Bellis</p> <p>Two studies indicate that the grading of beef livers can be performed objectively by means of the ratio between two height</p> <p>Primary Field: <u>Quality and Measurement</u>  Secondary Field(s): <u>Beef Liver</u></p>	<p>UNCLASSIFIED</p> <p>1. Liver, Beef.  Acceptability  I. Savich, A.L.  II. Surges, W.H.  III. Bellis, D.R.</p>
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1. **An Objective Method of Determining the Quality of Beef Liver**
2. **The Influence of Color and Conformation upon the Acceptance of Beef Liver**

**Interim Report**

**by**

**A. L. Savich, W. H. Surges, and D. R. Bellis**

**Meat Products Branch**

**Food Division**

**July 1963**

**Armed Forces Food and Container Institute**

## A MEASURE OF THE QUALITY AND ACCEPTANCE OF BEEF LIVER

1. An Objective Method of Determining the Quality of Beef Liver
2. The Influence of Color and Conformation upon the Acceptance of Beef Liver

### Summary

Two studies indicate that the grading of beef livers can be performed objectively by means of the ratio between two height measurements taken at specific points. The ratio of 0.50 between the shorter height and the taller height ( $\text{Height}_2/\text{Height}_1$ ) was adequate to allow the selection of high quality livers. The conformation of the liver was found to be highly significant in the selection of liver for quality as indicated by taste panel preference scores. Color was insignificant in the selection of beef liver.

## A MEASURE OF THE QUALITY AND ACCEPTANCE OF BEEF LIVER

### Introduction

The selection and grading of beef livers are determined by various characteristics thought to be indicative of liver quality. These quality characteristics are subjective and often controversial. The characteristics most commonly considered in determining quality are: color, compactness, firmness, fineness of texture, resiliency, sheen, smoothness, weight, and a combination of all the visual judgments, namely general appearance. These characteristics, for the most part, are ambiguous or have several frames of reference. For example, color usually is divided into uniformity and brightness.

At the present time the United States Department of Agriculture does not have grade standards for beef liver. The U.S.D.A. Meat Grading Branch classifies livers on their compliance with the requirements in Federal Specification PP-L-351, Liver. The description of grades (1 and 2) contained in this document is based on non-definitive characteristics similar to those mentioned earlier. Beef livers are commercially graded as Selected or Regular, based on similar characteristics of quality employed by the Federal Specification. In general, Grade 1 and Selected livers possess more of those characteristics deemed important and each to the extent considered necessary for assumed quality. One can readily see that the assigned grade of liver will vary as a result of the subjective method of evaluation, the error being compounded by the misjudgment of various combinations of characteristics.

This method of classification has been practiced over the years since no change or modification has been introduced. The criteria for classifying livers should provide, within the wide range of characteristics evaluated, a valid index of quality as established by the grading method.

Efforts made to review the literature regarding the subject were fruitless. The authors, therefore, were unable to justify the importance of the characteristics sought in high quality liver. The effect of these characteristics upon the preference for cooked liver also is unknown. The purpose of this report is to summarize the authors' work regarding the possibility of grading beef livers for specification purposes based on objective measurements to increase the degree of accuracy as obtained by subjective evaluations, and to evaluate the importance of color and conformation in determining liver quality as estimated by a taste panel.

## 1. Objective Quality Measurements

### A. Experimental Methods

In developing objective methods of grading livers it is necessary to know that measurable characteristics are indicative of quality. A total of 490 livers from two packing plants were checked for quality indicators using dimensional (length, width, and height) and weight measurements. In reviewing the characteristics of the measured liver, however, only 401 of the total were used, as extremely dark livers were excluded from the analysis of relationships. Due to the insufficient numbers of livers weighing less than nine pounds, these livers were

not evaluated. Hot livers were randomly selected and measured. The livers were then graded by the plant grader as either Selection 1 or Selection 2.

The method of measurement (Figure 1) for each of the above dimensional variables are as follows: with the visceral surface up, length was measured along the longest axis; width was measured at the widest point; height<sub>2</sub> was measured at the highest point where the peripheral blood vessels and surrounding fat (if present) penetrates into the thinner portion of the liver (this point will be on or adjacent to an imaginary line extending from the esophageal notch to the umbilical fissure); height<sub>1</sub> was measured at the highest point adjacent to the caudate lobe and the termination of the peripheral blood vessels at the thick end of the liver; and weight was ascertained in one pound ranges. The height measurements were made using a stainless steel probe 3/32 inches in diameter graduated at 1/8 inch intervals. The probe was designed with a tapered penetrating end and a ring at the opposite end to facilitate the process of probing and the removal from the liver. Linear measurements were made to the nearest 1/8 inch while the weights were recorded in whole number ranges of 6 to 16 pounds (X.00 to X.99).

#### B. Results and Discussion

All possible relationships of these variables to consumer quality were studied for significance. The only relationship showing significance was that of the ratio between height<sub>2</sub> and height<sub>1</sub> ( $P < .05$ ). Scattergraphs of the data from each plant were constructed to study the pattern of liver weight range and the ratio of height<sub>2</sub> and

height<sub>1</sub> ( $H_2/H_1$ ) for both Selection I and II plant graded livers (Figures 2 and 3). These data were then combined as shown in Figure 4. From the scattergraphs one can easily detect that the ratio of 0.50 ( $H_2/H_1$ ) is the distinct dividing point between livers plant graded as Selection I and II as determined by this height ratio. It was also found that fewer plant-graded Selection I livers occurred in the heavier weight ranges, fewer Selection II livers appeared in the lightweight range. A summary of the acceptance ratios are presented in Table 1. Utilizing the height acceptance ratio of 0.50 from the 210 livers graded as Selection I, 205 would be graded the same on the basis of this height ratio, while only 26 of the 191 Selection II livers would be graded as Selection I, 98 percent of the livers plant graded Selection I were graded as Selection I utilizing the height acceptance ratio of 0.50, while 14 percent of the livers plant graded Selection II were graded as Selection I. These relationships are also true for the height acceptance ratio of 0.49. Increasing the acceptance ratio, to obtain a larger number of blocky livers, decreases both the number and percent of Section I livers plant graded as Selection I and II. However, the decrease is greater for livers plant graded Section I than for Section II. Therefore, the advantage of utilizing a height acceptance ratio beyond 0.50 is questionable.

## 2. Influence of Color and Conformation

### A. Experimental Methods

Eighteen fresh beef livers were selected from a local packing plant, two of which conformed to one of nine combinations of color and conformation. Color and conformation were arbitrarily segregated

Table I

Beef Livers: Selection by Quantitative Methods

Number of Livers at or Above Acceptance Ratio ( $P < .05$ )

Plant	Selection	I		II						
		Accept. Ratio No.	No.	Accept. Ratio No.	No.					
Armour - St. Paul	111	.49	.51	.55	.49	.50	.51	.55		
		109	109	96	88	50	20	20	6	4
Wilson - Okla. City	99	.96	.96	.84	.65	141	6	6	2	1
		210	205	180	153	191	26	26	8	5

Percent of Livers at or Above Acceptance Ratio ( $P < .05$ )

Plant	Selection	I		II						
		Accept. Ratio No.	No.	Accept. Ratio No.	No.					
Armour - St. Paul	111	.49	.51	.55	.49	.50	.51	.55		
		98	98	87	79	50	40	40	12	8
Wilson - Okla. City	99	.97	.97	.85	.66	141	4	4	1.4	0.7
		210	98	98	86	73	191	14	14	4

into three groups each of which were subjectively described as excellent, fair, and poor. Excellent color was that of a uniform reddish dark brown; fair color was darker, while poor color was darker still, being almost black. Livers of excellent color and conformation were those of the highest magnitude for each of these two variables within this particular plant's supply of beef livers, while those of poor color and conformation were the lowest. Color and conformation of fair description were those livers possessing the mean subjective selection characteristics of excellent and poor and were predominant of the plant's volume. The combination of variables are as follows:

Color Excellent	-	Conformation Excellent
Color Excellent	-	Conformation Fair
Color Excellent	-	Conformation Poor
Color Fair	-	Conformation Excellent
Color Fair	-	Conformation Fair
Color Fair	-	Conformation Poor
Color Poor	-	Conformation Excellent
Color Poor	-	Conformation Fair
Color Poor	-	Conformation Poor

The livers were cut into slices 5/8-inch thick and griddle fried at 375°F. for approximately 10 minutes and then served to a taste panel to score for over-all preference. A balanced incomplete block design was utilized thus allowing 32 replications for each of the nine color conformation combinations. A nine-point hedonic scale was used by the non-technical panel members.

## B. Results and Discussion

The adjusted means for the treatments and over-all averages are shown in Table 2. Livers showing the highest acceptance were those of excellent conformation and fair color, while the least accepted were those of excellent conformation and poor color. The conformation of beef liver was significant at the 0.02 level. It appears that the panel members were able to distinguish between livers of excellent and poor-fair conformation (note adjusted means) on the basis of preference. Panel members were served portions of sliced liver and were not aware of the conformation prior to testing nor could they tell while testing the beef liver.

Table 2  
Adjusted Means for the Treatments and Over-all Averages

Conformation	Color			Average
	Excellent	Fair	Poor	
Excellent	6.67	7.28	6.56	6.84
Fair	6.70	6.34	5.89	6.31
Poor	5.62	6.66	6.47	6.25
Average	6.33	6.76	6.31	6.47

The color of liver was not significant ( $P < .10$ ). It appears that the panel was capable of distinguishing between livers of fair and poor -- excellent color (note adjusted means), however, they did not prefer liver with any degree of significance with regards to color. One must note,

however, that the color differences were derived on the raw liver and, possibly, upon cooking these differences in color were reduced to a mean color value, thus drawing the excellent and poor colored livers into a common uniform group of fair color preference.

The conformation and color interaction was significant at the 0.05 level, thus indicating that color is not completely independent of conformation.

### Conclusions

#### A. Objective Quality Measurements

1. The relationship of height<sub>2</sub> to height<sub>1</sub> ( $H_2/H_1$ ) was the only significant measured variable or relationship found in determining liver grade in two plants.

2. Based on data found in two plants the most desirable height acceptance ratio was 0.50 in the grading of Selection I and II livers.

3. The height ratio was equally as effective in grading livers as the combined weighed factors of color, compactness, firmness, fineness of texture, resiliency, sheen, smoothness, weight and general appearance, and can be determined in less time while being an objective method of grade determination.

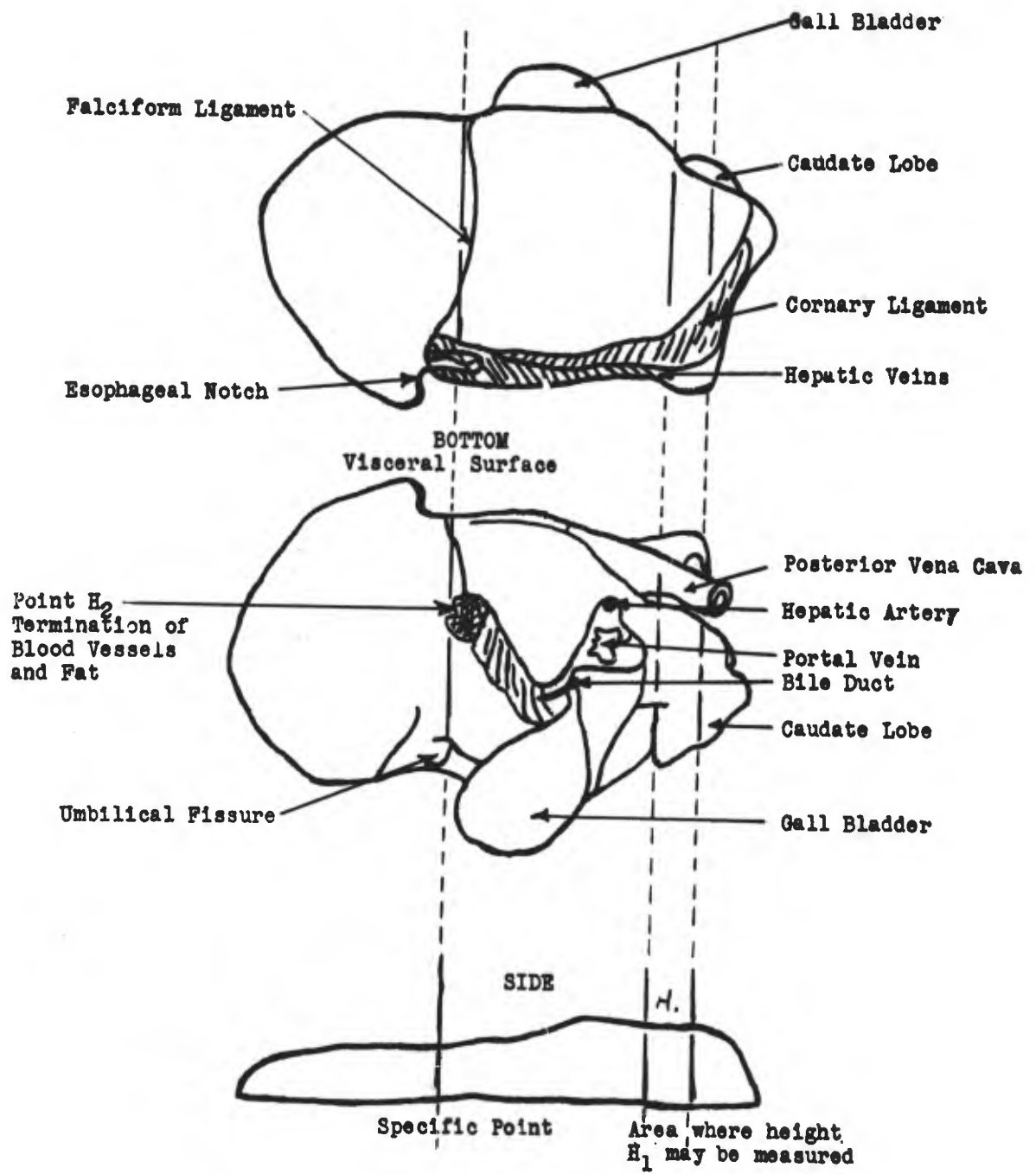
#### B. Influence of Color and Conformation

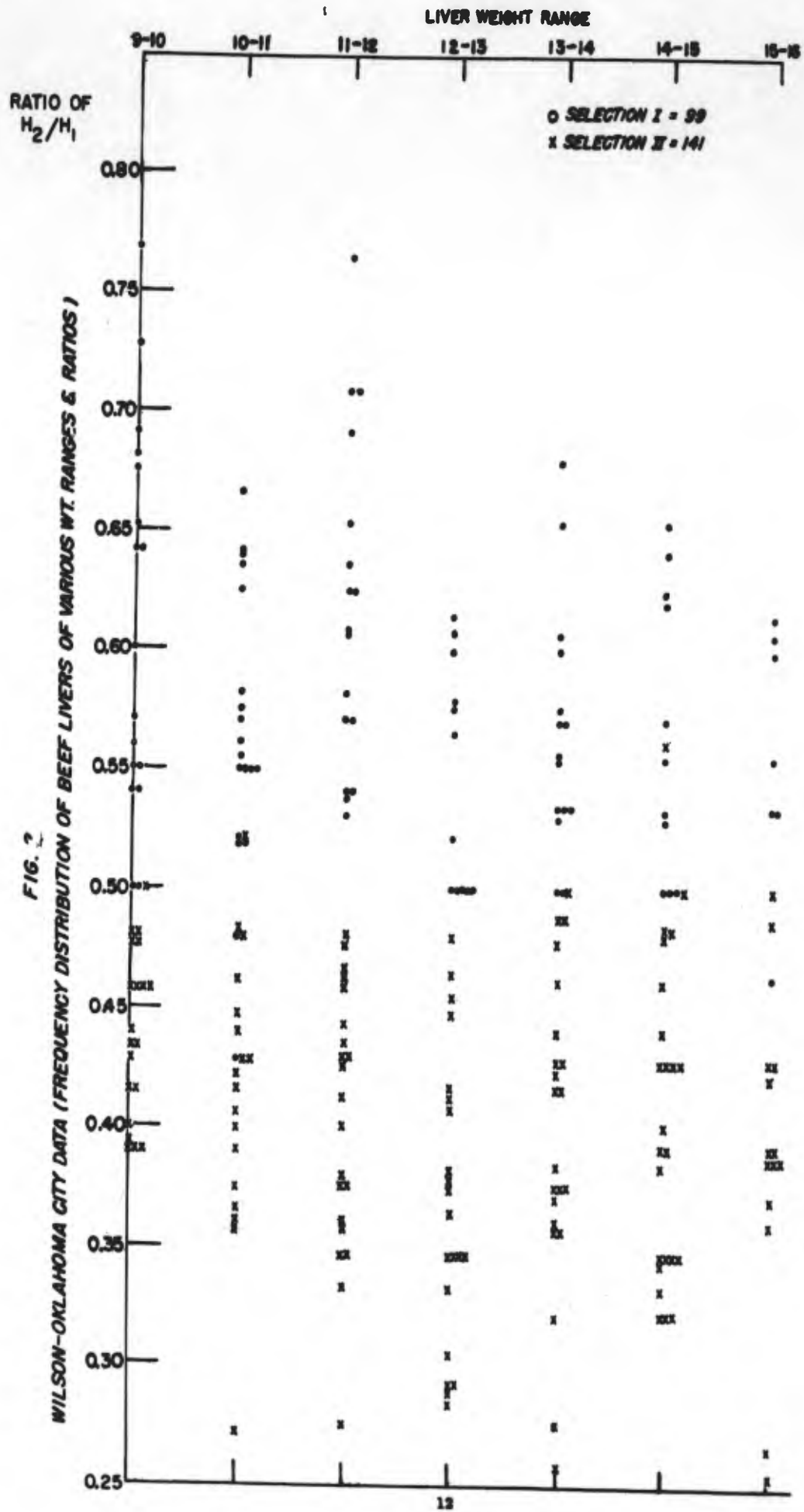
1. Livers of excellent conformation are preferred over livers having a less desirable conformation as indicated by taste panel preference scores, thus agreeing with the height ratio to the fact that conformation of liver is very important in determining its grade and acceptance.

2. No significant difference was found between livers of fair and poor conformation.

3. Color was not significant regarding beef liver preference, although panel was capable of detecting differences.

Figure 1





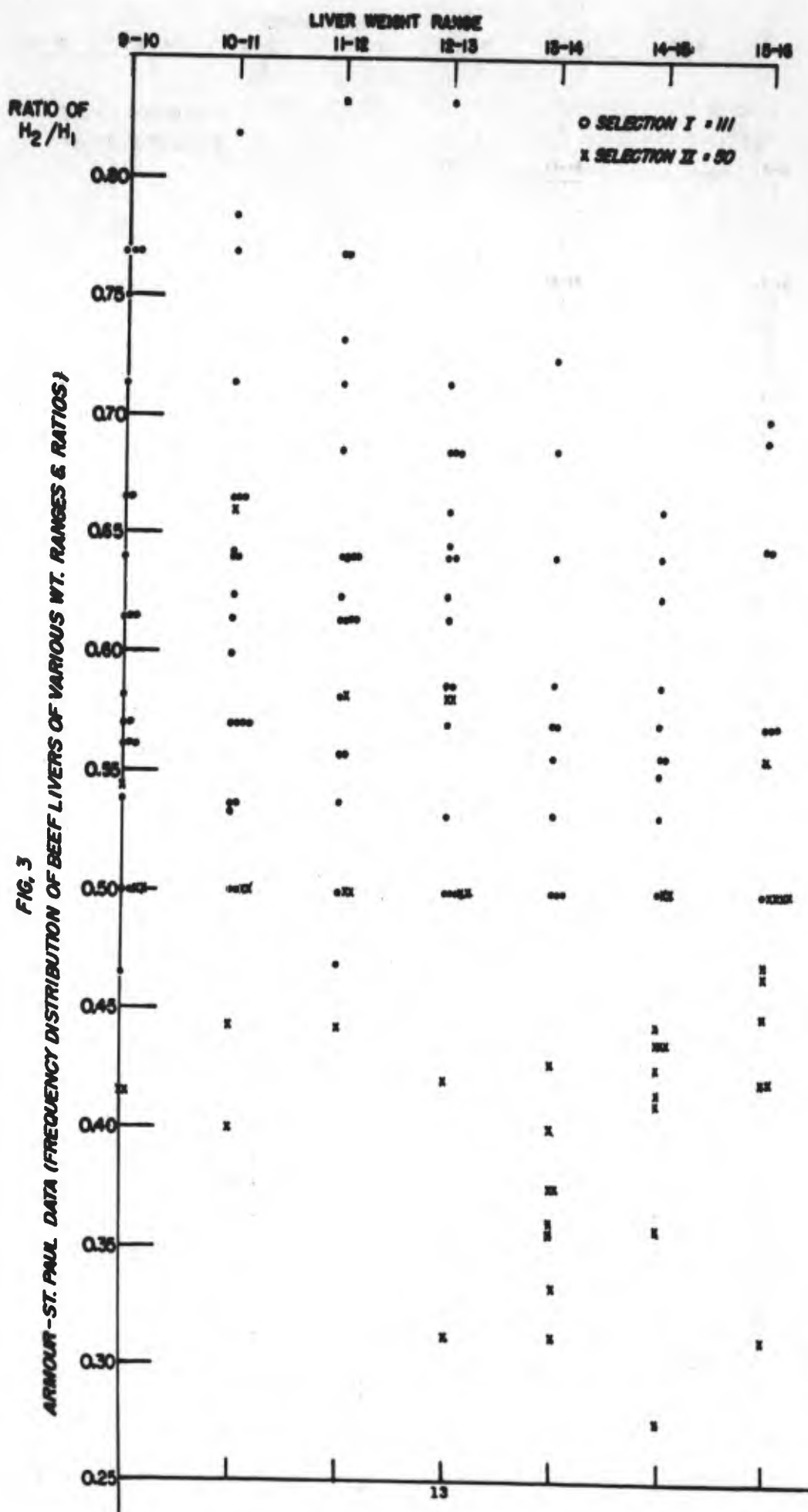
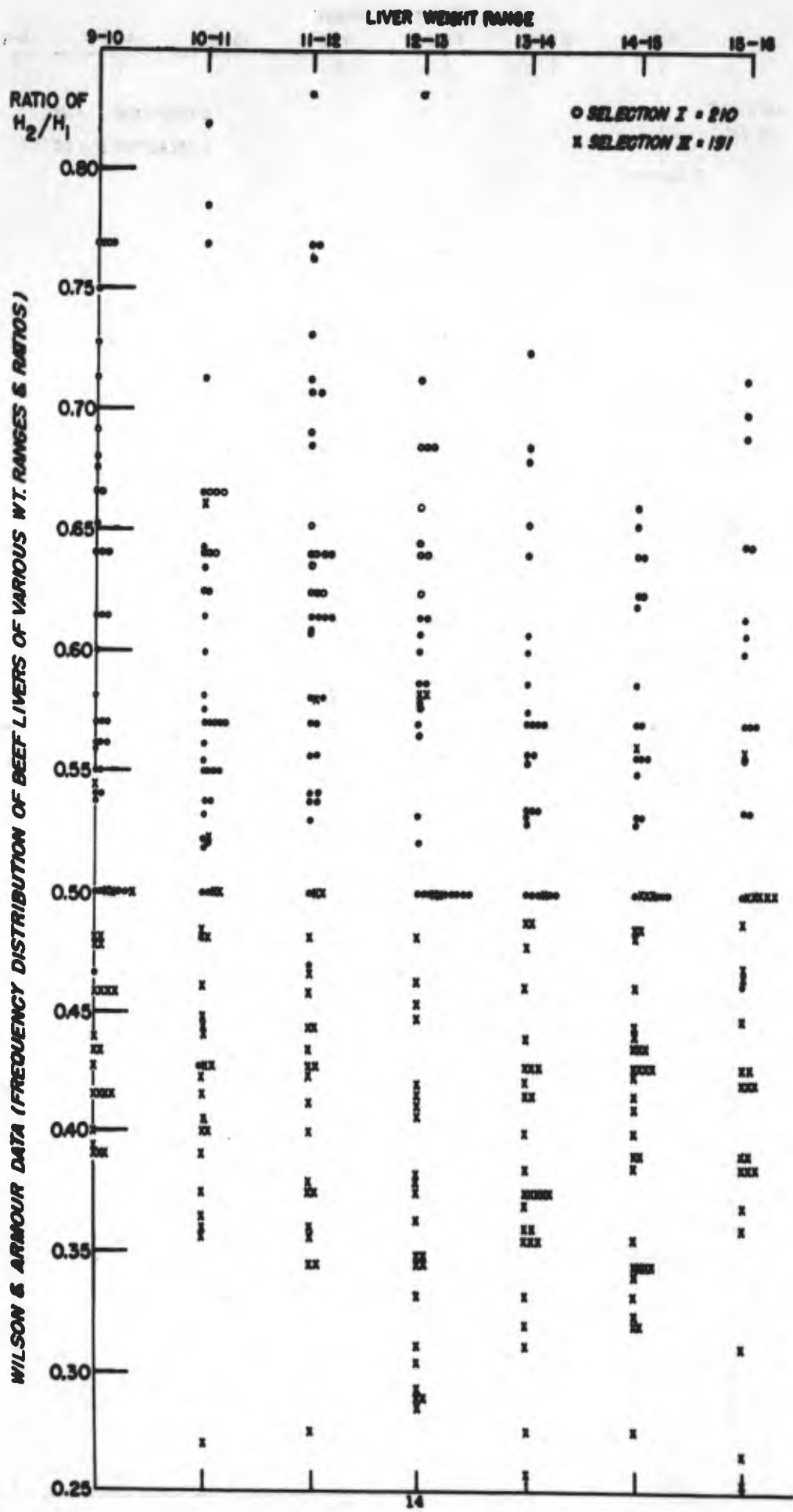


FIG. 4



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