

## ULTRASONIC SCANNING of CATTLE

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**SUMMARY :** *The composition of beef carcasses has considerable importance in animal production and meat marketing. Consequently, there is a need for reliable methods of estimating carcass composition particularly from measurement of living animal. Ultrascanning is one of the indirect objective methods used for prediction of carcass composition of live animals. Ultrascanning equipment are grouped into "A" mode, "B" mode and Real-time scanners. The results of experiments in which ultrasounds are evaluated indicate that in future, significance and extent of the utilization from the ultrasound will increase, as they are improve.*

### SİĞIRLARIN ULTRASONİK DEĞERLENDİRİLMELERİ

**ÖZET :** *Hayvansal üretim ve etin pazarlanmasında sığır karkaslarının kompozisyonunun bilinmesi ticari açıdan çok önemlidir. Bu nedenle, özellikle canlı hayvanların karkas kompozisyonunu tesbit etmek için güvenilir bir metoda ihtiyaç bulunmaktadır. Ultrason metodu, canlı hayvanların karkas kompozisyonunu tayin etmek için kullanılan indirekt objektif metotlardan birisidir. Ultrasonlar yapısal olarak "A" mode, "B" mode ve Real-time ultrasonlar olmak üzere üç gruba ayrılmaktadır. Değişik tip ultrasonların denendiği araştırma sonuçlarına göre, gelecekte ultrasonların geliştirilmeleriyle, hayvancılık sahasında önemleri daha fazla artacak ve pratik olarak kullanım sahaları yaygınlaşacaktır.*

### INTRODUCTION

One of the significant goals of the livestock and meat industry is to meet demands of consumer to type, composition and form of the end product of production. Today's consumers are demanding products which are lean, low in fat and calories, free from cholesterol yet highly nutritious with ultimate eating satisfaction (tenderness, juiciness and flavor).

During the last 15 to 20 years, the livestock industries in USA and European countries has made dramatic progress in reducing the fat content and increasing the lean content associated with domestic animals. Nevertheless, the average carcass from beef and lamb production still possesses about 30 to 35 % fat. In addition, the proportion of muscle in an animal's body may vary from less than 35 % to nearly 50 % of the body weight. In general, carcass traits have such

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higher coefficient of heritability, and therefore, it is important to have accurate methods for evaluating carcass quality in the live animal (Andersen, 1975 a).

Various subjective and objective methods have been developed to make indirect measurement of the anatomical composition of live animals. Among the objective methods, the ultrasonic techniques appear to have considerable potential as non-destructive and relatively accurate methods.

The ultrasound could be used for the following purposes:

1. In cattle breeding programs, it could help improve selection for carcass traits without requiring animal slaughter. In addition, progeny testing could be made more practical and less expensive, if measurements could be taken on progeny at an earlier age and carcass data collection in packing plant was minimized (Smith et al. 1989a).

2. Feedlot managers could utilize from the ultrasound to sort large groups of feeder cattle into uniform pens for feeding and marketing purposes (Smith et al. 1989b).

3. Processor could use the ultrasound to predict quantities of the lean and fat in the live animal and carcass, and they could pay to producers for the true value of their animals based upon lean. Processors could, in turn, sell carcasses and / or cuts to retailers based on lean. Then, they could provide lean meat to the customer (Smith et al. 1990).

## **PRINCIPLES and TECHNIQUES of ULTRASONIC MEASUREMENTS**

The ultrasonic technique is based on the principle of high frequency sound signals passing through tissue, but some sound is reflected back when an interface between two tissues is encountered (Ockerman and Davis, 1965). A pulse generator sends electrical pulses that are converted into high frequency sound waves in a transmitter. Then, these signals are passed through the hide of live animal. These sound waves are reflected at varying rates due to differences in density among the primary tissue types (bone, muscle, fat). The reflected signals are picked up by the receiver and can be amplified and shown in visual form by an oscilloscope. Variations in the time taken for the reflected signals to return to the transmitter (receiver) are used to measure the distances of the boundaries between tissues (Miller, 1978 ; Smith et al. 1989a).

Ultrasonounds are generally classified as "A" mode, "B" mode and Real-time ultrasonic machines. The three different types of ultrasonic equipment will be discussed in detail.

### **"A" Mode Scanning :**

In this system, output from video amplifier is sent to an oscilloscope and echoes appear on the screen as spikes, spaced at intervals on the time base line (Figure 1). This arrangement is used

in several of simple ultrasonic machines, namely Sonatest, Medata etc. In some types of "A" mode ultrasounds, the position of the spikes is converted to a direct digital reading of fat thickness (Kempster et al. 1982).

**"B" Mode Scanning :**

Until recently, most scanners (ultrasounds) employed a single transducer to progressively build up a scan over a time. The equipment built for use in hospitals has been, in general, bulky and delicate. Equipment for scanning of farm animals had to be manufactured specially.

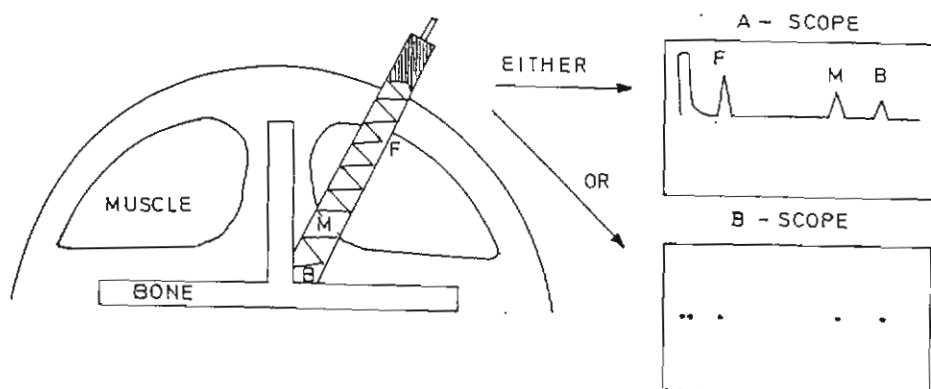


Figure 1. Two Ultrasonic Pulse-Echo Displays.

In "B" mode display, reflections are applied as negative pulses to the cathode of a cathode ray tube so that they modulate the brightness on the time base line. Therefore, the reflections appear as bright spots on the screen (Kempster et al. 1982).

Three types of "B" mode scanners that have different methods of action and coupling were developed. These are called as the simple scanners with mechanical coupling, the simple scanners with electrical coupling and the compound scanner with electrical coupling .

1. Simple Scanner with mechanical coupling (Scanogram): The instrument has been widely used for animal evaluation for a long time (Tulloh et al. 1973 ; Andersen et al. 1975a; Miller et al. 1978). In this machine, the probe (transducer) is motor driven a long special track, shaped to fit the

animal's back. A two dimensional scan on an oscilloscope is built up by holding the shutter of a Polaroid camera open as the probe travels the length of the track (Figure 2a).

2. Simple Scanner with electrical coupling (Ilis Observer): The transducer of this scanner is housed in an oil bath and moves along a straight rail on turning a handle (Figure 2b). Its position is synchronized electrically with the display. Coupling to the back of animal is achieved via a flexible membrane (Kempster et al. 1982).

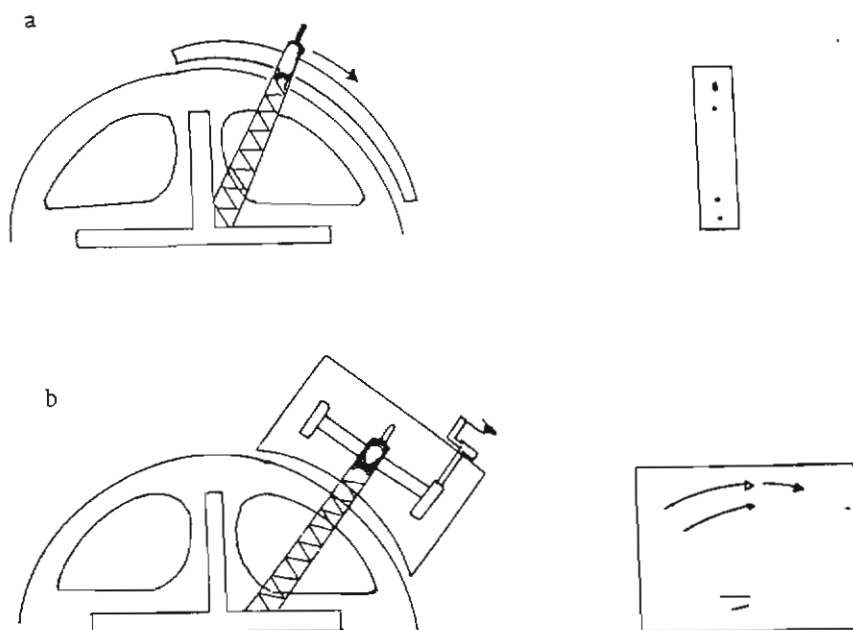


Figure 2. "B" Mode Scanners Used in Livestock Evaluation. a) Simple Scanner with Mechanical Coupling, b) Simple Scanner with Electrical Coupling.

3. Compound scanner with electrical coupling (SVC Scanner): The transducer is held on two straight arms. Potentiometer that is available in this type of "B" mode scanner measures angles to define the position and orientation of the transducer. Therefore, appropriate signals to send X

and Y plates of a storage oscilloscope are generated. In operation, the probe is moved in contact with the skin and rotates to examine echo producing structures from various angles and points of view (Andersen, 1975a).

**Real - time Scanning :**

Real-time scanning was originally developed to use in hospital to enable the physician to see rapid internal physiological movements such as the beating of the heart. The scanner uses a single transducer mounted in a water bath at the focus of a parabolic reflector. The transducer, which is motor driven, rotates so that the tissue is rapidly and repetitively scanned with a parallel beam (Figure 3).

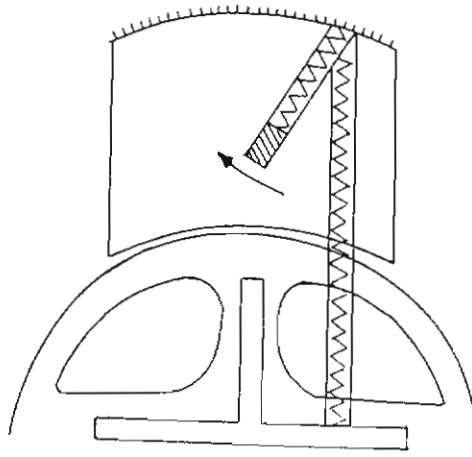


Figure 3. Real-time Scanner Using a Transducer Which Rotates at the Focus of a Parabolic Reflector

During last few years, several companies have produced scanners that use a transducer that is made up of an array of piezoelectric elements. These scanners produce a practically instantaneous picture by rapid electronic switching from element to element. The equipment is small and reasonably robust. The ultrasound built for use in hospitals can also be used for scanning of farm livestock (Figure 4).

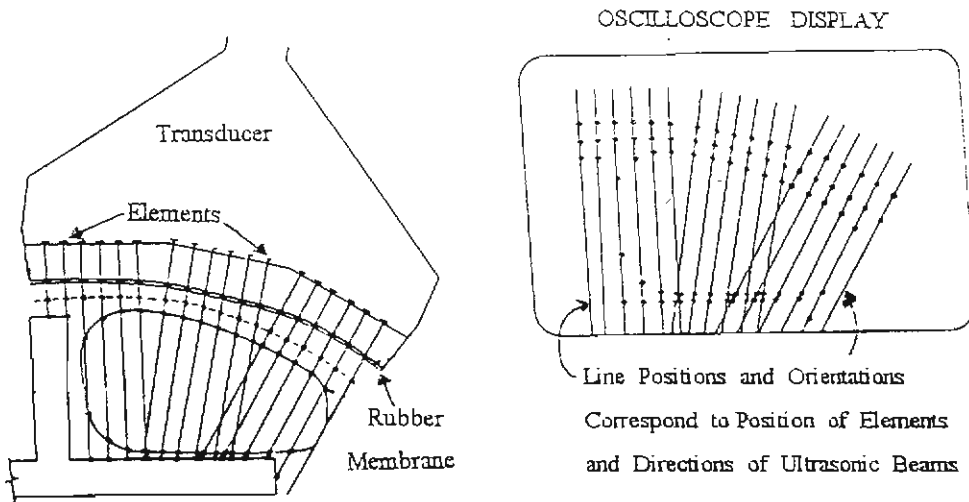


Figure 4. A Schematic Drawing Illustrating the Principle of Real-time Scanning Using a Multi-Element Probe.

An image on the real-time scanner is built up as follows:

A transmission pulse is applied to the first element and then, a short pulse of ultrasound is sent into the tissue. Echoes produced as the pulse passes through acoustic interfaces are picked up by the element used for transmission. Later, the echoes are displayed by brilliance modulation of a time base, and positioned on oscilloscope screen to imitate the direction and speed of travel of the ultrasonic pulse. After a delay, second element is fired and the process is repeated. By fast electronic switching, all elements are eventually used in transmission and reception. Therefore, a complete frame, an image consisting of a series of parallel lines, is built up on the oscilloscope screen.

Danscanner is an ultrasonic equipment that has been recently developed for evaluation of farm animals.

## PRECISION OF ULTRASOUNDS IN THE PREDICTION OF BEEF CARCASS COMPOSITION

The first works on the ultrasonic measurements of beef cattle were conducted by Temple et al. (1956) and Stouffer et al. (1959). In last two decades, several studies dealing with this topic were reported by Gillis et al. (1973); Tulloh et al. (1973); Andersen (1975b); Tong, et al. (1981); Henderson-Perry, et al. (1989); Jones, (1989); Smith et al. (1989b); Strasia et al. (1989); Smith et al. (1990).

Tulloh et al. (1973) used Scanogram ultrasound machine on 14 Aberdeen Angus and 15 Holstein Friesian steers. After scanning, the cattle were slaughtered and their carcasses were dissected. The correlation values between ultrasonic and actual measurements for back fat depth ranged from 0.56 to 0.94 and residual standard deviation from 2.8 to 5.4 mm. The corresponding values for ribeye muscle area measured with Scanogram and directly on the carcasses ranged from 0.32 to 0.76 and from 4.1 to 6.8 cm<sup>2</sup> respectively.

In a study carried out by Gillis et al. (1973), Krautkramer and Scanogram equipment were compared in terms of the accuracy of prediction for fat thickness and ribeye area. It was concluded that estimation of ribeye area by using Krautkramer was more accurate than prediction of same muscle area by employing Scanogram. The correlation coefficients between actual and ultrasonic ribeye muscle area ranged from 0.32 to 0.88 by using Krautkramer and from 0.17 to 0.56 by using Scanogram. The corresponding residual standard deviation ranged from 2.3 to 5.3 cm<sup>2</sup> and from 5.2 to 6.1 cm<sup>2</sup> respectively. Same researchers reported that use of Krautkramer equipment was very time consuming and requires an experienced operator. However, Tong et al. (1981) reported that measurement of subcutaneous fat thickness by Scanogram resulted in better and consistent results than the measurement of back-fat thickness by using Krautkramer. The correlation values between ultrasonic and actual fat thickness measurements ranged from 0.50 to 0.57 by Krautkramer and from 0.53 to 0.61 by Scanogram.

Ockerman and Davis (1965) made ultrasonic evaluation of 51 beef cattle in Ohio, and reported that correlation coefficients computed for actual carcass measurements and ultrasonic evaluation for ribeye area and back-fat thickness were 0.9. Their results pointed out that ultrasonic measurements could be used as an estimator of fat covering and ribeye area of beef cattle.

Danscanner, a real-time scanner, was used in a research carried out by Busk, (1982). Correlation coefficients between ultrasonic and actual measurements for ribeye area and subcutaneous fat thickness were 0.87 and 0.89 respectively. In another study, the correlation values between ultrasonic ribeye area measurement and percent lean or percent fat were found to be

statistically significant ( $P < 0.05$ ). The values were 0.31 and 0.37 respectively. The residual standard deviation values were 1.6 and 1.7 respectively. According to the researchers, Danscanner gives a better description of circumference and area of ribeye. Therefore, it describes carcass composition better not only regarding the lean / fat ratio but also the lean / bone ratio.

Smith et al. (1990) reported high correlation value ( $r = 0.81$ ) between ultrasonic fat thickness and actual values obtained by using a real-time scanner. Nevertheless, ultrasonic ribeye area measurements were moderately correlated with actual values ( $r = 0.63$ ). It was concluded that ultrasonic measurements are accurate in determining carcass subcutaneous fat thickness, but, ribeye area estimates are inconsistent and warrant further investigation.

Three hundred fifteen yearling beef steers were ultrasonically measured for subcutaneous fat thickness and ribeye area by Smith et al. (1989a). Live animal ultrasonic measurements were compared to actual carcass measurements to determine the accuracy of these values. Estimates of fat thickness were within one tenth of one inch of actual 75 % of time and ribeye area was predicted within one square inch of actual 37 % of time. The results suggested that ultrasonic measurements of subcutaneous fat thickness are quite accurate in determining carcass fat thickness, but ribeye estimates are relatively imprecise.

Inconsistent reports concerning accuracy of ultrasounds in predicting carcass ribeye area and back-fat thickness have appeared in literature. The difference among the results could also be accounted for the operator's ability to interpret hide, fat and muscle boundaries. The lack of the ability of operator may cause for decreasing the accuracy in the prediction as indicated by Tong et al. (1982) and Henderson-Perry et al. (1989).

## CONCLUSION

Ultrasonic imaging equipment technology has been increasingly progressed approximately during last forty years. However, it still needs to be developed. The accuracy of ultrasonic equipment is giving hope about their future. Nevertheless, skill and expertise of the operator are still important on the accuracy of the prediction of carcass composition.

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