

On-Farm Application of the Brix Refractometer for Estimating Sow Colostrum Immunoglobulin G in Commercial Pig Herds

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Abstract. The Brix refractometer is a commonly used instrument for measuring the soluble solid content of a liquid and is traditionally applied to estimate sugar concentration based on refractive index. However, Brix values also reflect other components, including proteins such as immunoglobulin G (IgG). In livestock production, the Brix refractometer is widely used as a practical tool for assessing colostrum quality. This study aimed to evaluate the use of a Brix refractometer for on-farm prediction of sow colostrum IgG concentrations in a commercial pig herd, using enzyme-linked immunosorbent assay (ELISA) as the reference method. Data on Brix values (%) and IgG concentrations (mg/ml) were obtained from 105 colostrum samples collected from French Landrace × Yorkshire sows (average parity 3.1 ± 2.1). Colostrum samples (5 ml) were manually collected within 3 h after the birth of the first piglet in the litter. The Brix value was measured immediately using a Brix refractometer and the remaining samples were stored in clean bottles at $-20\text{ }^{\circ}\text{C}$ until IgG analysis. Spearman correlation analysis was performed to examine the association between Brix values and colostrum IgG concentrations. On average, the Brix value was $28.0 \pm 3.4\%$ (range: 20.2–39.7%), and IgG concentration was $47.7 \pm 11.6\text{ mg/ml}$ (range: 20.5–78.9 mg/ml). A significant positive correlation was observed between Brix value and IgG concentration ($r = 0.637$, $p < 0.001$, $n = 105$). These findings suggest that Brix values can serve as a reliable proxy for colostrum quality in commercial pig herds.

1 Introduction

Compared with milk, the first mammary gland secretion, known as colostrum, is characterized by high concentrations of immunoglobulins (Ig) and lower levels of lactose and lipids [1]. During the first days of life, adequate colostrum intake is essential for the survival and health of newborn piglets. A previous study demonstrated that piglets consuming less

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than 200 g/kg body weight had a mortality rate of 50.3%, compared with 5.5% in those that consumed 301–400 g/kg body weight between day 1 and day 7 postpartum [2]. This finding underscores the critical role of sufficient colostrum intake in early piglet development. In addition to being an important energy source, colostrum serves primarily to provide passive immune protection through its IgG content [1,3]. However, IgG concentration in colostrum varies considerably among sows and breeds [4,5].

The Brix refractometer, originally designed to measure sugar concentration based on refractive index, is widely used to determine the soluble solid content of liquids. Nevertheless, Brix values also reflect other components, including proteins such as IgG. In livestock production, the Brix refractometer has become a practical and rapid tool for assessing colostrum quality [6,7,8,9,10]. Therefore, this study aimed to evaluate the applicability of the Brix refractometer for on-farm prediction of sow's colostrum IgG concentrations in a commercial pig herd, using an enzyme-linked immunosorbent assay (ELISA) as the reference method.

2 Materials and Methods

2.1 Animals

A total of 105 French Landrace × Yorkshire crossbred sows from a commercial swine herd in Thailand, with an average parity of 3.1 ± 2.1 , were included in the experiment conducted from June to July 2022. The sows and gilts were moved to the farrowing house and housed in individual farrowing pens (4.83 m²) one week before the expected farrowing date. During the study period, the average daily temperature inside the barn was 28.4 ± 2.8 °C, and the average relative humidity was $78.0 \pm 15.1\%$. The animals were continuously monitored (24/7) during this transition period until farrowing. Once farrowing began, continuous supervision was maintained.

2.2 Brix index and colostrum IgG analyses

A 5 mL colostrum sample was collected by hand milking within 0–3 hours after the first piglet was born in each litter [6,11]. The Brix value was measured immediately using a handheld refractometer (Pocket PAL-1, Atago, Tokyo, Japan), and the result was expressed as a percentage (%). The remaining samples were stored in clean bottles in a freezer at –20 °C until analysis. Colostrum immunoglobulin G (IgG) concentration was determined using an enzyme-linked immunosorbent assay (ELISA), as described by Taechamaeteekul et al. [12]. Before analysis, centrifugation of the colostrum samples was performed at $15,000 \times g$ for 20 min at 4 °C using a Centrifuge 5810 R (Eppendorf AG, Hamburg, Germany). After careful removal of the fat layer, the liquid fraction was collected and diluted 1:500,000 in a sample conjugate diluent containing 50 mM Tris buffer, 0.14 M NaCl, 1% BSA, and 0.05% Tween 20. The colostrum IgG concentration was quantified using an ELISA quantitation kit (Bethyl Laboratories Inc., Texas, USA), and the results were expressed in mg/mL. The inter- and intra-assay coefficients of variation for the ELISA were 1.52% and 2.77%, respectively.

2.3 Statistical analyses

Statistical analyses were conducted using SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA). Descriptive statistics for the Brix index (%) and colostrum IgG concentration (mg/mL) were obtained using the MEANS procedure. All variables were expressed as mean

± standard deviation (SD). The association between Brix values and colostrum IgG concentrations was assessed using Spearman's correlation analysis.

3 Result and Discussion

The present study demonstrated a significant positive correlation between the Brix index and colostrum IgG concentration in commercial pig herds raised under tropical conditions. On average, the Brix value was $28.0 \pm 3.4\%$ (range: 20.2–39.7%), and the IgG concentration was 47.7 ± 11.6 mg/mL (range: 20.5–78.9 mg/mL). A significant positive correlation was observed between the Brix value and IgG concentration ($r = 0.637$, $p < 0.001$, $n = 105$). A very similar correlation was reported by Hasan et al. [6], who found an association between Brix values and ELISA-measured IgG concentrations ($r = 0.63$, $p < 0.001$, $n = 153$), while O'Brien et al. [13] reported a stronger correlation between Brix values and IgG concentration measured by radial immunodiffusion ($r = 0.810$, $p < 0.001$, $n = 40$). These findings suggest that Brix measurements can serve as a reliable on-farm proxy for colostrum quality in commercial pig herds. The colostrum IgG concentration observed in the present study was comparable to that reported by Juthamane et al. [14] (54.9 ± 24.6 mg/mL) in tropical environments and slightly lower than that reported by Kielland et al. [4] (53.9 mg/mL) under temperate conditions. Previous studies have suggested that an adequate colostrum IgG concentration should be ≥ 50 mg/mL, corresponding to a Brix index of $\geq 25\%$ [2,6].

In conclusion, The present study demonstrated a strong positive correlation between refractometer-derived Brix values and ELISA-determined colostrum IgG concentrations in sows under tropical conditions. The observed Brix and IgG values were consistent with previous studies conducted in both tropical and temperate regions, confirming that the Brix refractometer is a reliable on-farm tool for assessing colostrum quality.

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