1. Introduction

1.1. Background of the study

Livestock is an important part of the farming system in developing countries, particularly for subsistence and semi-commercial farmers like in Indonesia. There is potential to improve food security and family income by improving livestock production.

Sheep is an important meat resource in Indonesia (MASON, 1978) and its development has been centered in Central Java (DIREKTORAT JENDERAL PETERNAKAN, 1997). The sheep population during the last five years according to livestock statistics data increased yearly. The sheep population in 1995 was 4 353 441 head and in 1999 reached 7 225 690 head (BIRO PUSAT STATISTIK, 2001).

This increase in sheep population has led to a proportional increase in feed-stuff demand. For sheep production, the farmers have used rice bran as an energy source. However, due to competition with other animal species (goats, cows, pigs and poultry) the use of rice bran is being inhibited by high price. Investigations into alternative feedstuffs that are less or non-competitive are necessary.

A potential feedstuff whose use is not in competition with requirements of other animals is cassava waste, especially cassava peel (CaP). This by-product is available throughout Indonesia since cassava plants can grow in poor soils with limited fertilizer and water. The potential of CaP in Indonesia is high, when viewed against the rapid increase in cassava production over the last 10 years. In 1995 the production of cassava was 15.44 million tons and in 2000 it reached 20.53 million tons (BAPPENAS, 2001). According to WARDHANA *et al.* (1994) the ratio between cassava tuber and peel is 20 %, so CaP amounts approximately to 4.11 million tons per year. Until now CaP has not been optimally utilized.

The nutrient content of CaP is relatively similar to the nutrient content of cassava tuber, with a high carbohydrate and a low protein content. However CaP contains cyanide glucosides especially linamarin and lotaustralin (FAO, 1990), so before CaP is used for animal feeding,

it should be treated to improve the nutritive value and to decrease the Hydrogen cyanide content to safe levels for animals.

Fermentation is a simple method and it can improve nutrient content (WINARNO, 1990). It is also common in Indonesia and generally people use *Saccharomyces cerevisiae (SC)* as an inoculum or starter in the fermentation process for making traditional foods such as "cassava tape" and "rice tape". After fermentation, the products become soft, sweet smelling and more digestible (RUKMANA, 1998).

Little research effort has been directed towards the use of CaP as a feed-stuff for ruminants. This research followed the general framework depicted in figure 1.1.

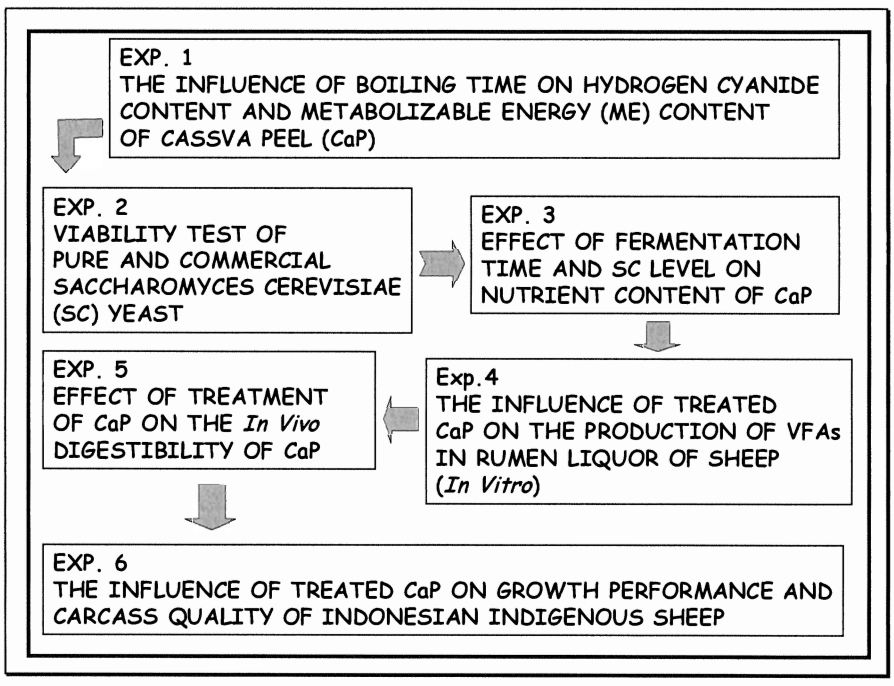

Figure 1.1. Outline of research

The goal of this research work is to improve the growth of Indonesian indigenous sheep through use of treated CaP in place of rice bran in the diet.

1.2. Objectives of the study

The specific objectives of the study are:

1. To find the optimum boiling time of CaP to reduce hydrogen cyanide acid (HCN)

content,

2. To compare and determine the viability of pure and commercial *S. cerevisiae* cultures for possible use as inoculum for boiled CaP,
3. To determine the effect of duration of fermentation and level of *S. cerevisiae* inoculum on nutrient content of CaP,
4. To determine the influence of boiling and fermentation of CaP on the production of Volatile Fatty Acids (VFA) in rumen liquor of sheep using an *in vitro* method,
5. To determine the digestibility of treated CaP using an *in vivo* method,
6. To assess the growth performance and carcass quality of indigenous Indonesian sheep given concentrate supplement containing treated CaP instead of rice bran.

1.3. Hypotheses

The specific hypotheses of the study are:

1. Viability of pure *S. cerevisiae* is better than commercial *S. cerevisiae* cultures.
2. Boiling time can decrease HCN content of CaP.
3. A combination of duration of fermentation and level of *S. cerevisiae* inoculum can increase nutrient content of CaP.
4. Boiling followed by fermentation of CaP can increase VFA production in rumen liquor (*in vitro*).
5. Digestibility of fermented CaP is better than digestibility of boiled and fresh CaP.
6. Growth performance and carcass quality of indigenous Indonesian sheep, which have been given concentrate supplement containing fermented CaP is better than if boiled CaP is used.

2. Literature review

2.1. Cassava peel

Cassava peel (CaP) is one of the major by-products from some industries that use cassava as raw material (IFUT, 1987). It is the outer cover of the tuber, which is usually removed manually with a sharp knife with little or no pulp in the process of turning the raw pulp into the various human foods and tapioca among others in many tropical countries (IITA, 1990).

Cassava peel production is positively correlated to production of cassava (SUDARYANTO *et al.* 1989). Cassava production in Indonesia according to BAPPENAS (2001) has increased over the last 5 years. The cassava production in 1995 was 15,44 million tonnes, while in the year 2000 it was 20,531 million tonnes. On average CaP production is 20,1 percent of the tuber (HAHN *et al.*,1986; IFUT, 1987; SUDARYANTO *et al.*,1989). Based on this value and the cassava production published by BAPPENAS (2001), the CaP production in Indonesia in the year 2000 was 4,106 million ton.

Anatomically, if the mature cassava is cut transversely it has two distinct tissues (Figure 2.1). The parenchyma, which is the edible portion of the fresh root, comprises approximately 80 percent xylem vessels radially distributed in a matrix of starch-containing cells (WHEATLEY and CHUZEL, 1993). The peel layer (cortex), which is comprised of sclerenchyma, cortical parenchyma and phloem, constitutes 20 percent of root weight (BARRIOS and BRESSANI, 1967).

According to IBRAHIM *et al.* (1994) CaP consists of thick and thin peel (Figure 2.2). The thick peel is white or pink, while the colour of thin peel is brown (MUHIDDIN, 2000). The peel is 1 – 4 mm (NARTEY, 1979). In addition, the part of CaP that can be used for animal feeding is the thick peel.

2.2. Nutritive value of cassava peel

Proximate and mineral content of cassava peel and other part of cassava plant like leaves and tubers from some researcher is shown in Table 2.1 and Table 2.2.