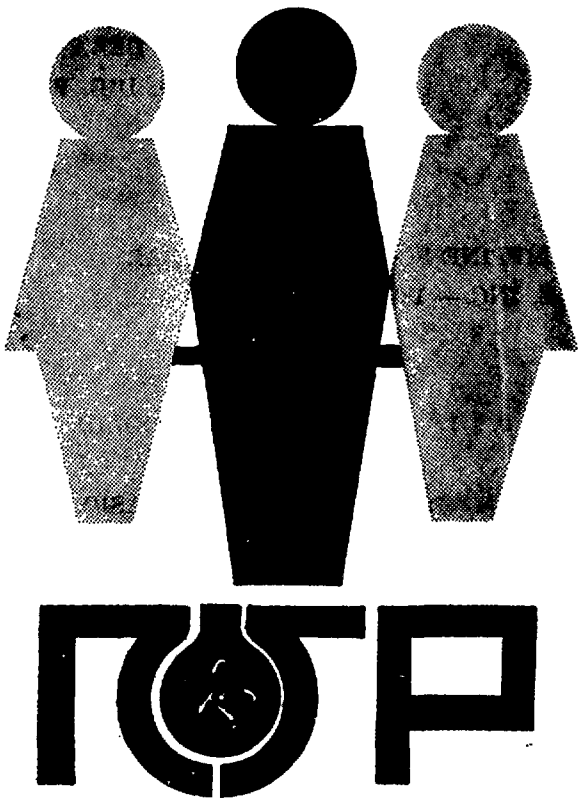
PROCEEDINGS

OF THE 1977 JOINT ANNUAL CONVENTION

RADIOISOTOPE SOCIETY OF THE PHILIPPINES INC. AND THE PHILIPPINE SOCIETY FOR NUCLEAR MEDICINE



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FOREWORD

The Radioisotope Society of the Philippines and the Philippine Society of Nuclear Medicine met in a joint annual convention on November 11, 1977 on the theme "Radioisotope for the Common Man," a subject which proved not only relevant to the times but one which supports the government's thrust of countryside development.

It is our hope that with this publication, a compilation of the scientific papers presented during the convention, our objective of attaining professional growth in our societies shall have been attained.

EULINIA M. VALDEZCO
Editor

ACKNOWLEDGMENT

Our Societies gratefully acknowledge the financial support of the PHILIPPINE ATOMIC ENERGY COMMISSION for the publication of this PROCEEDINGS.

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SCIENCE AND THE COMMON MAN

Speech by Secretary Blas F. Ople

Doctor Villadolid,
Commissioner Ibe,
Doctor Kintanar,
Distinguished Members and Guests,
My Fellow Workers
Ladies and Gentlemen:

When I received your invitation to address this Convention, I unhesitatingly accepted, thinking it would just be another opportunity to plug for the cause of the Filipino worker—but in the next moment, I regretted my decision. For what would I know of nuclear science? Even as a student, what little of chemistry, whether organic or inorganic, qualitative or quantitative, that I had managed to absorb—the abstruse theories and abstract terminologies — I promptly forgot soon after school. So what business would I have addressing a distinguished group of nuclear chemists, physicists and scientists such as this?

Indeed, even as I stand here before you, I am abashed at my colossal temerity in presuming I could attune myself to your casual and matter-of-fact scientific papers and discussions on atomic and molecular structures, on protons and electrons and neutrons, on valence and radioactivity, on physical and chemical properties and such, ad nauseum—all the awesome results of years and years of patient and painstaking research, experimentation and observation.

But I was bailed out of my dilemma on being reminded that the theme of this joint convention is: "Radioisotopes for the Common Man." In other words, the theme of this meeting is a challenge, the challenge of how you, the leading Filipino scientists of today, can bring science to bear on the problems of the Filipino common man. For to a large degree, all our hopes and efforts to change our economic condition and modernize our society ultimately depends on how successfully we are able to employ science for the benefit of the common man.

It may be argued, and I believe quite convincingly, that science is not yet benefiting the common man—we have what appears to be a dualism in science —whereby the rich or the "haves" could avail of the latest technological blessings such as the heart pacers, satellite communications, or the SST. But these are things which remain alien to the experience of say, Mang Pedro who makes less than three hundred pesos per month. With his wife and five children, he earns barely enough to give them three decent meals a day, much less afford him the "luxury" of odd bus rides or a first-run movie.

To this day the advances of science have not really penetrated the lives of the ordinary Filipino. Majority of Filipino homes, for instance, do not have the basic provision for electricity or piped water. In fact, you would be surprised at the number of homes relying on the **kingke** for light—a gadget which we think belong to the pre-industrial revolution era.

In medicine, the same inequity exists. For where else do we find the most advanced medical equipment, the most sophisticated apparatus but at the Makati Medical Center? And yet, Mang Pedro does not go to MMC when he is sick, for the simple reason that he can't afford the cost of sophisticated treatment. If at all, he goes to a provincial hospital where, as a rule, not only are the equipments antiquated, but the service dismally poor.

But while it appears that the com-

mon man is the least benefited by science, it is he who suffers the most from its dire effects. The ordinary workers are usually the first victims of toxic substances simply because they are exposed to them 40 or more hours a week. Each year throughout the world, grim statistics indicate the increasing number of injuries and even deaths arising from continued exposure of workers to such substances.

In the Philippines, we don't have, as of now, exact figures measuring the extent of damage chemicals has wrought on workers. But we have reasons to believe that as in other countries, it is on the rise.

Recently, the Employees' Compensation Commission appended a new list of compensable diseases to include work-related ailments resulting from exposure to such substances as cadmium fumes and vinyl chloride.

A Presidential Directive has likewise been issued for the establishment of an Institute of Occupational Health and Safety which would provide expertise and the capability to detect the risk factors to which the workers are increasingly being exposed in the working environment.

While it is everyone's responsibility to make life and environment safe at all times, I think you are in the ultimate position to alleviate this condition. I know that the responsibility is tremendous for scientific breakthroughs do not come in neat packages but always with accompanying disastrous effects.

On this, we may draw from the experiences of other countries. In China for instance, the main criteria for judging any scientific discovery is whether it would benefit the masses. Anything less is casually discarded. In the United States, we have the interesting example of Henry Ford who believed that cars must be made available to the middle income American and decided to manufacture **en masse** a new cheap and functional vehicle — the "Model T" which may be the world's ugliest car but one that revolutionized American society.

This I think should be the philosophy that should guide our scientific pursuits. In our quest for alternative sources of energy for instance, the ultimate goal should be to make energy cheap enough to make them available to the common man.

In our search for greater productivity, we need to continue expanding the list of agricultural crops being developed so that we may duplicate the coup we have thus far made in rice and in other crops such as coconut and sugar. And incidentally, I have learned that you are doing a very good job in developing better varieties of these products by the use of radioisotopes. That there is now a new variety of sugar cane which is relatively shorter and which do not fall very easily to the ground, solving the problem of wastage before harvest. Developments such as these are certainly commendable and should be encourmaged to benefit other industries and an increased number of people.

The task before us now is decidedly heavy. Not only do we have to make science function for the greatest number at minimal social risks, we have to accomplish so much in so very little time. Burdened with an ever rising population amidst depleting resources, and with heavy competitive pressures from the more developed West, we must now double, triple our efforts to cope up with our needs.

It is projected that in a little over 20 years, at the turn of the century, our population would have reached 85 million, roughly double our current number. Much of what we have now in terms of natural resources, would have been seriously depleted by that time. But through science and through the efforts of people like you, we don't foresee these things to vanish. We in fact expect them to be in greater abundance. But to be able to do this, to perform this economic miracle, we have to act now.

LOCAL EXPERIENCE ON RADIONUCLIDE MYOCARDIAL IMAGING IN THE PHILIPPINES AT THE PHILIPPINE HEART CENTER FOR ASIA

Edmundo V. Villacorta, M.D.
October 1977

The Nuclear Medicine Department of the Philippine Heart Center was inaugurated and became fully operational 11 months ago. Imaging instruments include a 10 inch. gamma-camera interfaced to a data storage/retrieval system with area of interest selection and histogram capabilities, cardiac gating, multiformat film printer and whole body scanning table. Although a computerized data processor and a portable gamma-camera are available, these two instruments have been in-operative.

Since the department became operational, 547 cardiovascular procedures were performed out of a total of 2447 various procedures. Educational and informational campaigns[1,2,3,4] to both doctors and public as well as analysis of results in collaboration with the Research Division and other departments of the PHCA were launched since then. The cardiovascular procedures are availed of free-of-charge to registered PHCA patients excepting for the costly Tl-201 imaging.

Earliest analysis on myocardial imaging procedures was done on 15 out of 64 cases of coronary perfusion. A preliminary report was presented and published[5] on the results. The procedure is performed during coronary arteriography by intracoronary injection of albumin particles labelled with Tc99m. Correlating the imaging findings with those of arteriography, the cases were grouped into the four combinations.

Group	Arteriogram/ Imaging	No. of Cases		
I	NA/NP	9	60%	Normal study
II	NA/ABP	1	6%	Further study needed
III	ABA/NP	3	20%	Candidate for bypass
IV	ABA/ABP	2	13%	Not candidate for bypass
		15	Total	

Since coronary perfusion imaging evaluates perfusion at the precapillary and capillary levels, areas of decreased radioactivity are considered non-viable and unsuited for coronary bypass. Only areas adequately perfused though supplied by critically narrowed arteries are suitable for surgical bypass. Procedure is safe; no chest pain, ECG or BP changes occured during the intracoronary injection of the radioactive particles under controlled condition. Good quality images demonstrate deficient myocardial perfusion at the capillary and pre-capillary levels, therefore of considerable influence in the selection of cases for coronary bypass surgery. Coronary perfusion imaging should be an integral part of coronary arteriography.

The non-invasive evaluation of myocardial perfusion using Tl-201 has also been studied by the department. Tl-201 is expensive and not readily available. Fortunately, our studies have been supported by the National Research Council of the Philippines and the National Science Development Board. In the GXT room of the department, Tl-201 is intravenously administered at the height of exercise done in a fasting state. Ten minutes after the exercise, imaging is then performed with a gamma-camera. If perfusion defect is present, delayed imaging after another 4 hours will serve as a resting state. Results on the analysis of 93 cases out of 171 performed were presented and reported in publications[6,7,8].

No. of Cases	GXT	Tl-201
47 Normal controls	(—)	(—)
26 Typical Angina	+ 69.2%	+92.3%
20 Old infarction	25	53.8% positive for ischemia
93 Total		

Our experience shows better sensitivity of Tl-201 than exercise ECG for detection of ischemia. Tl-201 is also twice more sensitive than ECG for old infarction with co-existing ischemia when delayed imaging is obtained. Acute and old infarction can also be detected and distinguished from ischemia by delayed imaging; further, site and extent of the lesion are provided. However, its high cost limits its application to equivocal cases, for example, ischemic cases with abnormal resting ECG, positive GXT but assymptomatic cases and in ventricular arrythmia during exercise but without significant S-T changes.

Another non-invasive procedure for the detection of acute infarction is the radionuclide imaging using a bone radiopharmaceutical, Tc99m pyrophosphate. Analysis of 40 out of 57 patients performed has been reported in two publications[6,9]. Done within the first week of attack and an hour after the IV administration of Tc99m PYP, patient is transferred from the CCU to the Nuclear Medicine Dept. under the close supervision and ECG monitoring of a cardiologist. In majority of cases, positivity of the procedure begins as early as 12 hours and maximizes at 48 hours. Radioactivity begins to fade on the 7-8th day and usually to finally disappear on the 14th day.

No. of Cases	ECG & Enzymes	Tc99m PYP	
23 with Chest Pains	(—)	(—)	
15 Acute Infarct	(+)	(+)	88.2% positivity
12 transmural			
3 subendocardial			
2 Subendocardial	(+)	(—)	
40 Total			

With the ECG and enzyme studies as the basis, 23 cases without acute infarction gave negative Tc99m PYP results, while the other 17 cases proven for acute infarction, the Tc99m PYP was able to pick up 88.2% of cases. This is therefore a sensitive for the detection of acute infarction and can provide information as to the site and extent of the lesion as well. However, acute infarction is readily apparent from the clinical, ECG and enzyme

findings and therefore, Tc99m PYP has been relegated to equivocal cases. Other conditions which may cause Tc99m PYP accumulation in the myocardium are unstable or stable angina, aneurysm, valvular calcifications or other forms of myocardial injury such as in cardioverted cases.

In summary, coronary perfusion imaging should be an integral part of coronary arteriography. Barring the expensive cost of Tl-201, the non-invasive Tl-201 myocardial perfusion imaging is ideal for detection of coronary heart disease. Acute infarct imaging is a valuable adjunct to ECG and enzyme studies.

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RADIOISOTOPES IN INDUSTRY

Barry W. Popple
Ecco-Asia

In the Philippines to date, it is safe to say that a minimum of 95% of users of radioisotopes in industry require the sources for the purpose of radiography. The remaining percentage require isotopes for thickness, level or density measurement and tracer experiments.

A. RADIOGRAPHY:

The purpose of radiography is to produce a negative reproduction of a radiation image and view the negative in order to evaluate whether a material being tested meets a certain quality standard or other acceptance criteria.

Basically, the process involves the subjection of materials to high gamma radiation energy. The intensity of the beam of radiation of gamma rays undergo local attenuation as it passes through a heterogeneous body due to the absorption and scattering of the radiation by the object under test. As a result, the emerging beam from the object forms at the surface of the film, areas of differing intensity which together make up the radiation image. The image obtained when the film is developed is a negative reproduction of the radiation image.

Among the known elements, there are more than 800 isotopes of which, more than 500 are radioactive.

Common radioisotopes used in industrial radiography however are tabulated below representing a very small portion available.

Element	Isotope	Half-Life	Penetrating Power (MeV)	Half Value Layer (mmPb)	Thickness Steel
Iridium	192	72 days	0.31-0.6	2.6	5- 50 mm
Cesium	137	33 yrs.	0.66	8.0	20- 60 mm
Cobalt	60	5.3 yrs.	1.17-1.33	13.0	30-150 mm
Thulium	170	130 days	.084- .052	<1 mm	0- 10 mm

* Range of minimum and maximum thickness of steel permitting a sensitivity of 1%.

The properties of the isotope have also been tabulated in consideration of what is desirable to the user.

HALF-LIFE:

Should be as **LONG** as possible. It is desirable to maximize use of the source for economic reasons as well as to consider the activity of the source as being constant during exposure periods.

PENETRATING POWER:

A **HIGH** MeV is desirable for penetration purposes but the higher the MeV, the harder is the radiation and as a result film contrast is lower. Bearing in mind that higher contrast improves the sensitivity of the radiograph, the above table shows the steel thickness ranges for a given MeV range.

HALF VALUE LAYER:

Should be as **SMALL** as possible for purposes of shielding. It is desirable to reduce the size and weight of the storage container to a minimum for easy portability. Radiation Safety Regulations however ultimately limit the

smallest size permissible.

The higher the penetrating power, the thicker must be the shielding material. In practice, the shielding head, or storage container is made of lead, or depleted uranium, i.e. materials of high density.

SPECIFIC ACTIVITY:

A **HIGH** specific activity is always desirable in radiography. Specific activity is measured in curies/gm. Therefore, for a given desirable curie strength, a radioisotope having a higher specific activity will be smaller in size. The size of the source is very important to the radiographer because small "pin point" sources produce sharper images on the radiograph. Man made isotopes are used in industrial radiography because natural radioisotopes such as radium and mesothorium have a specific activity too low for the practical purpose of producing an acceptable radiograph.

Half-life, penetrating power, half value layer and specific activity are therefore the major factors in considering a practical source to use, and as of today, only the four 4) radioisotopes mentioned above can be considered as practical for the purpose of industrial radiography.

ADVANTAGES IN USING ISOTOPES:

1. Needs no power or cooling system like an x-ray machine does.
2. The focal spot is small permitting the production of high sensitivity radiographs.
3. They have high penetrating power for their size in relation to bulky x-ray machines.

DISADVANTAGES IN USING ISOTOPES:

1. Usually gamma rays produce poorer contrast radiographs than x-rays.
2. Short half life.
3. Cannot be switched off. It must pass through 10 half lives before the source can be considered as having negligible activity to require shielding. For Co^{60} that period is 5.3 years.
4. Radiation intensity level cannot be adjusted to suit material thickness and material density.

APPLICATIONS—(Radiographic Testing)

a. **Weldments** — For fusion defects, undesirable inclusions, cracks and penetration.
b. **Castings** — Cold shuts, microshrinkage, hot tears cracks and foreign inclusions.
c. **Forgings** — Convolution cracks, foreign inclusions.
d. **Semi-conductors** — Form, alignment, damage, broken internal hardware.
e. **Process equipment** — Blockages, normal/malfunction, corrosion erosion.

B. THICKNESS MEASUREMENT (Including level & density)

The purpose of thickness measurement is to obtain thickness readings through pipes and vessels when only one side of the material is accesible. This measurement can usually be taken even when the equipment is in operation and falls under on stream inspection tools.

The basic principle is to position a sealed source on one point of the equipment and collimate the radiation beam to a scintilation counter at another point on the equipment. A knowledge of the absorption characteristics (half value layer)) of the material is necessary in order to convert radiation intensity at the measuring probe point to material thickness. A test specimen is normally required for purposes of calibrating the scintillation counter.

Sources Used:

Radium ..... (Half life 1,622 yrs.)

$Cesium_{137}$ ..... 33 years
$Cobalt_{60}$ ..... 5.3 years

High Specific Activity is not a requirement, a long half life is. Due to their long half-life, the sources remain a constant health hazard to the users and possibly non-users and are therefore used only in the **milli**-curie range, facilitating storage too.

A high penetrating power is also essential for thick steel sections up to 200 mm.

ADVANTAGES:

Small activity, high penetrating power, long half-life.

DISADVANTAGES:

Radiation hazard, low accuracy, scintillation counter expensive. (Normally done today using ultrasonics).

APPLICATION — Thickness, Level, Density, Measurement of:

a. **Process Equipment** — pipes, vessels, tubes, tanks refinery units for erosion, corrosion liquid level, liquid density.

***Lining Material** — Thickness of linings e.g. rubber lining inside steel pipes can be measured using this technique which cannot be done using ultrasonics.

C. TRACING:

The purpose of tracing is to investigate flow patterns, leakages, mixing or isolation of various substances the behaviour of which cannot normally be seen, heard, smelt, felt or otherwise detected.

The basic principle is to add a radioisotope to the substance (usually in liquid form) under investigation and follow its flow pattern by detecting the radiation given off the mixture using a highly sensitive radiation counter.

SOURCES USED:

The types of sources used or are available are very many and will depend on the substance under investigation for purposes of dissolving or suspending.

Sources in the milli-curie range **and** having short half-lives, e.g. 2-3 days) are desirable because usually the public is a potential to the radiation hazards. However, due to the dilution factor, the radiation or active contamination is very very minimal.

APPLICATIONS: (Surveys, Experiments:)

a. **Leakages** — Submerged oil pipelines, water drains, sewage lines.
b. **Flow patterns** — Sewage disposal in the sea, rivers, tide and current behaviour.
c. **Mixing** — Pipelines, process lines, tanks and vessels.
d. **Erosion and Corrosion** — Pipes and pipe linings, vessels and tanks.

APPLICATIONS OF RADIOISOTOPE METHODOLOGY IN AGRICULTURAL RESEARCH AT U.P. LOS BAÑOS

Ramon Samaniego
Professor, Dept. of Chemistry, UPLB

Three recent applications of radioisotope methodology in agricultural research at U.P. Los Baños are as follows:

RASHED-UL-QUAYUM, a Ph.D. Candidate major in Soil Science, minor in Plant Nutrition worked on the "Phosphorus-Zinc interactions in sugarcane fertilization and nutrition".

In order to ascertain the nature of P-Zn interactions in soils, four soils were incubated with varying levels of P; ^{65}Zn was applied at the end of incubation period (45 weeks), and the availability of ^{65}Zn was determined by four extractants in terms of retention and release. It was concluded that EDTA and dilute HCl extractants may find good correlation with the available Zn status of soils. There was no evidence of unfavorable P-Zn interaction in soils which could render soil Zn insoluble.

The temporary influence of P on soil Zn was further investigated by Zn adsorption in P saturated soils. All four soils were saturated with phosphate ions (0.1 N KH_2PO_4, pH 6.5), and the adsorption of Zn was achieved by high (1 to 30 ppm) and low (1 to 5 ppm) concentration ranges of Zn in the equilibrium mixtures which were equilibrated for 24 hours. The amount absorbed by P saturated soils versus controls were plotted against Zn concentration of equilibrium solutions, linear regression models were constructed and Langmuir's constant adsorption maxima and strength of adsorption) were computed. The results showed that Zn adsorption was increased by P saturation, but at the same time, the strength of adsorption decseased as compared to to the untreated soils. A negative adsorption was also observed in very dilute systems of Zn equilibrium concentrations. It was suggested, therefore, that P-Zn interactions in soils were not of any significance in rendering soils Zn unavailable, from the view point of permanent fixation.

The sugarcane leaf concentrations of P and Zn generally declined as the plants grew, but showed some accumulation patterns towards maturity. Phosphorus applications, although not effective initially, did increase P adsorption by leaves and depressed Zn accumulations. Similarly, Zn levels exerted a slight depressing influence on the leaf P content but at the same time showed a strong beneficial effect on the leaf Zn content .It was also pointed out that P fertilization in combination with Zn levels, did not cause adverse P-Zn interactions.

There was evidence of physiological P-Zn interactions. Applied P resulted in greater leaf Zn content falling below that of roots; roots accumulating more Zn. Zinc applications generally showed a greater rise in leaf Zn than for roots and stalks, both of which exhibited declining tendencies. In general, P fertilization caused reduced Zn absorption by leaves because of unfavorable P-Zn interactions, whereas Zn content of roots and stalks were shown to be in-

creasing. Zinc applications generally levelled off such adverse differences. Phosphorus applications, on the other hand, indicated negative relationships with the root and stalk P, and positive ones with the leaf P content.

The physiological nature of P-Zn interactions was tested on sugarcane. Effect of high P in the nutrient solution was to produce high P roots which favored an accumulation of root Zn. Such an accumulation could be in the root cells and/or at the surface membrane, whenever nutritional imbalance between P and Zn occurred; and consequently, lesser amount of Zn was translocated to the shoots, particularly the leaves. The nature of physiological interaction was suggested to be a root cell and/or a surface membrane phenomenon resulting in the formation of an insoluble Zn-P complex.

CHESED ALCOSEBA, an MS candidate, Botany major, Plant Physiology minor worked on "The Uptake and Translocation of phosphorus by rice under soil moisture stress".

Rice seedlings var. IR-20 were allowed to absorb radioactively labelled P either from a nutrient solution or from calumpang clay to determine the effect of soil moisture stress, P concentration, and evaporative demand on its uptake and translocation. It was found that uptake tended to decrease with decreasing water potential of the external medium most probably because the roots themselves became physiologically incapacitated to absorb the nutrients. Increasing the concentration of P in the external medium increased uptake correspondingly only when the plants were unstressed; otherwise, response was nearly negligible.

In both soil and nutrient solution, the patterns of P uptake were similar with respect to moisture stress and P concentration indicating that mostly physiological factors limited uptake during stress. However, with respect to evaporative demand, uptake generally tended to be greater when evaporative demand was low among soil-grown plants whereas variable results were obtained among solution-grown ones. This was attributed to changes in the concentration of P ions at the root surfaces. A high evaporative demand generally tended to depress the uptake of P particularly among the soil-grown plants possibly because under such a condition the plants were experiencing a greater degree of internal water deficit.

Translocation from the root to the shoot was reduced when evaporative demand was low and the plants were not under stress. When it was high, distribution of the absorbed P was more or less even throughout the plant.

PHAN-QUAN-VINH, a Ph.D. candidate, major in animal physiology, minor in meat science and biochemistry is working on "Some factors affecting serum creatinine phosphokinase activity in pigs and its relation to porcine stress susceptibility and post mortem meat quality.

Stress susceptibility is an important problem to commercial meat industry and daily management practiced by animal husbandmen since it has been known to be intimately responsible for sudden deaths of pigs which were exposed to inevitable stresses such as transport, high ambient temperature, chasing, crowding, etc. It was also closely related to the incidence of poor post-mortem quality of meat.

Animal producers may suffer significant loss and consumers may be supplied with a low quality and less nutritions kind of meat due to the increased exudate. In countries where backyard raising of animals is still the main source of supply of animals for meat, the expected losses due to death of stress-susceptible pigs may discourage small-scale, low investment pig raisers and backyard raisers. Should a quick and easy-to-do method be established to identify stress-susceptible

pigs early at weaning or at certain stages of their life, it would be hopeful to exclude susceptible animals from the breeding herd and/or certain treatments and special management could be properly applied.

The possibility of using serum CPK activity as an index of porcine stress susceptibility will be determined.

Forty-eight healthy pigs weighing from 10 to 20 kg classified into 4 genotypes will be used in this experiment. Experimental pigs will be fed with ration containing 3200 kcal. ME/kg with crude protein level of 18 percent of the ration to meet the nutrient requirements as reported by the National Research Council (USA). Vitamin and mineral supplement will also be incorporated in the formulated ration. Calcium and phosphorus requirements for optimal growth will be supplied at 0.91 percent and 0.75 percent of the ration.

In this experiment, established differences between SS and SR pigs such as significantly high serum ACTH levels observe in SS pigs in unexposed state, abnormally high body temperature and significantly high lactate concentration in blood of SS pigs exposed to heat stress, and other symptoms of porcine stress susceptibility serve as criteria to identify SS animals. Comparisons between the distribution patterns of serum ACTH and lactate levels and reactal temperature among SS and SR pigs with their distribution pattern of serum CPK activity will be the means by which utilization of serum CPK activity obtained from unexposed pigs as a quick and less expensive index of stress susceptibility may be evaluated.

After 15 days of adjustment to the ration used in this experiment, blood samples (5 ml) will be collected from the jugular vein of these experimental animals. Sterilized needle and syringe containing no anticoagulant will be used. Serum will be separated as soon as possible and kept frozen until used. In order to minimize errors which may be introduced by diurnal variations of ACTH concentrations and CPK activity, 48 animals will be divided into two groups with 24 pigs per group. Blood samples of the first group will therefore be collected from 8 a.m. to 9 a.m. and those of the second group will be withdrawn at the same period of time in the next morning. These serum samples will be used or determination of ACTH levels and CPK activity.

Forty-eight pigs will be divided into six groups forming a 4 x 2 factorial RCB experiment with six replications. Every six pigs of the same sex and breed will be randomly assigned to each of six blocks. These six groups of pigs will be exposed to solar heat stress from 10 a.m. to 1 p.m. one after another within six days. Order of exposure will also be randomly scheduled.

Pigs to be exposed to solar heat stress will be restrained in stalls made up of wooden bars on concrete floor (6 m x 2 m). No shade and no water will be provided. Rectal temperature will be read every one hour interval. Blood withdrawal from jugular vein will be done every hour at 10 a.m., 11 a.m., 12 noon, 1 p.m. and 2 p.m. Separations of serum will be done as described above and kept frozen for further determination of lactate and CPK activity. Relative humidity and air temperature at the exposure site will also be measured by psychrometer. Various symptoms of porcine stress susceptibility will be carefully observed. In order to prevent aaccidental death of susceptibe animals, cold water will be readily prepared to treat them when necessary.

Serum ACTH levels will be determined by radioimmunoassay technique using ready-to-use ACTH immunoassay kit of Amersham/Searle Co. Lactate in serum sample will be quantified by the method of Barber and Summerson as described by Oser (1965). Assay of CPK activity will follow the method of Bernt and Bermeyer (1965).

Based on the 4 x 2 factorial RCB experimental design, single and interac-

tion effects of breeds and sexes on the serum ACTH, lactate levels, CPK activity and rectal temperature will be determined by analysis of variance.

If breeds and sexes as well as their interaction do not appear to affect the values of above-cited parameters, pooled data will be used to graph the frequency distribution of each parameter among experimental animals. It is expected that a bimodal distribution will result, therefore, median value instead of mean value will be used as the point of separating the two populations. Difference in population means will be tested by t-test. The identification of SS and SR population in respect to the differences in serum ACTH levels, serum lactate levels and rectal temperature values will be useful for the analysis of of discriminant function by which the probability of misclassification of SS and SR pigs with regard to the frequency distribution pattern of serum CPK activity depicted from pooled data of 48 pigs may be assessed. In this manner, a single value of CPK activity may serve as an index of stress susceptibility regardless of breeds and sexes.

However, if breeds and sexes and/or their interaction do affect serum levels of ACTH, lactate CPK activity and rectal temperature. and if serum CPK activity could be proved to be a good predictor of stress susceptibility, more than one value of serum CPK activity must be used as index value which in this case is not identical for different breeds of pigs and sexes.

This research work is in progress.

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