Title of Project:

Nutrient content of offal-containing sausages and polonies

LITERATURE REVIEW

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LITERATURE REVIEW

1. BACKGROUND INFORMATION

The soaring price of meat and processed meat products necessitates the extensive utilisation of inexpensive meat by-products for human food. Prior to the food price crisis in 2008, more than 850 million people were undernourished (IDRC and CIDA, 2011:2). The Food and Agriculture Organisation of the United Nations warned that already as of May 2009, over 1 billion people were undernourished. The World Bank has estimated that under current conditions, global food production would have to double by 2030 to meet increasing global demand. One of the World wide nutritional deficiencies is Protein. There is a large source of animal protein going to waste on a daily basis from abattoirs world-wide due to lack of frozen storage. Most local offal products are consumed 'fresh' but hawkers have a shelf-life problem as their products on the back of their 'bakkies' (pick-ups) have begun to compose by the time they reach their clients as the temperatures there may easily reach 40 deg C due to hot climate in S.A. (South Africa). (Hinze, 2009).

In South Africa animal by-products such as offal meat are popular to be cooked directly because these products are preferred by consumers to have a fresh natural taste (cultural preference) and are not fully utilized for the commercial production of value-added meat products such as fresh and emulsion-type sausages for human consumption. Since all the processing takes place at ambient temperatures the offal must be sold fresh and subsequently the offal has a very limited shelf life and the potential for food borne infections and intoxications is great.. In order to provide more nutritious, affordable high quality protein products, the use of selected non-meat protein ingredients in fresh and emulsion-type meat products has been advocated by various researchers (Yetim *et al*., 2001:97). **Meat extenders** are defined as

non-meat proteins that are available for use in emulsion-type sausages to improve consistency, emulsifying and water binding capacities. They also serve to enhance the protein content, improve processing yields and reduce formulation costs. Cheaper sources of protein that are available locally should be applied to extend emulsion-type meat products while maintaining acceptability and nutritional quality. According to Magoro (2007:3), different offal parts such as beef livers, hearts, spleens, lungs, stomachs and intestines can be used successfully as protein ingredients during the development of fresh meat sausages. Beef spleen, heart, liver and lungs were found to be good sources of iron when compared to a beef shoulder (Magoro, 2007:83). Therefore the utilisation of these products will add benefits of natural fortification with iron when used during sausages making.

On reviewing literature, researchers such as Krishnan and Sharma (1990: 51-60) have utilised buffalo offal meat such as Rumen and Heart during the development of emulsion-type buffalo meat sausages. Tripe meat has been used by Pearson and Tauber (1984:109) for sausage making and they have also advocated the inclusion of beef heart in sausages. In Northern countries, offal is usually processed into fine value-added products like liver batters, liver sausages, blood sausages tripe sausages - like andouille or andouillette in France (Chyr et al., 1980). Pork intestine are widely used as casings in the sausage industry. Limited research has been conducted on the processing of ready-to-eat emulsion-type meat products such as polony using offal meat such as; red beef offal parts (beef livers, beef hearts, beef spleens, beef lungs) with various other processing aids. Oliveros *et al*; (1982:7) found beef spleen to have high emulsion capacity and least emulsion stability than other meat by-products such as beef tripe and heart.

2. OFFAL DEFINITION

Offal" – the so-called fifth quarter of the beef carcass - is consumed by a large proportion of the SADC's (Southern African Development Community) population, which makes it an important part of the cultural "food basket" of the majority of people in Southern Africa (Magoro, 2007:3). "Offal" is also

known as “Mala le Mogodu” in Sotho and “Mala Mangulu” in Venda. It is a traditional dish preferred mostly by black South Africans (both young and old), due to its affordability and unique taste (Horton & van der Heever, 1972:258). The black population in South Africa prefers roughly cleaned tripe, as it is claimed that the residual injesta on the beef tripe acts as a natural flavourant during cooking (Horton & van der Heever, 1972:251).

According to Ockerman & Hansen (1988:13) “offal” has been defined by the United States Meat Industry as the meat-slaughter by-product or everything produced by or from the animal, except the dressed meat. In South Africa, **edible offal** of food animals other than poultry: blood, blood plasma, brain, cow-heels, diaphragm, gut (casings), washed head, kidneys, omentum, pancreas, pluck (oesophagus, trachea, lungs, heart, pericardium, associated lymph nodes, pillars of the diaphragm and liver or part thereof (without the gall bladder)), spleen, tail, thymus, tongue, cleaned tripe, trotters and udder (in the case of a heifer), (SANS 885:200X,5).

Edible offal is of significant economic value for the SADC meat industry, as a large proportion of the SADC’s population consumes it - in spite of the fact that it is regarded as a highly perishable product due to being part of the gastro-intestinal tract of the slaughtered animal (Horton & van der Heever, 1972:257). According to Hayes (1989:633-655), some of the factors negatively affecting the utilization of edible beef offal is that the youth **of today** have not experienced the diverse and different tastes of offal. Another factor is that offal requires more preparation and takes long to cook. **Edible offal** is mostly sold fresh with no value-adding done to it. Therefore, adding value to it through processing methods such as making fresh and emulsion-type meat sausages could also benefit the Small, Micro and Medium Enterprises (SMME’s).

3. CLASSIFICATION AND DESCRIPTION OF BEEF OFFAL

Beef offal can also be classified as “red” and “rough”, in order to differentiate liver, spleen and lungs from rough stomachs and intestines.

3.1 Red offal

"Red offal" means the lungs, heart, liver, diaphragm, spleen, tongue and demasked head of the slaughtered animal (Department of Agriculture, 2004:3). Red offal parts are kept in a separate area from the rough offal in order to prevent cross-contamination.

3.1.1 Liver

The ruminant liver, according to Frandson (1981:267), is located immediately behind the diaphragm and tends to be located on the right side of the large stomach arrangement. It is classified as a compound tubular gland, although its cells appear more like cords or plates than like tubes. It has a thinner left lobe called the thumb piece, with a slight tail (Ockerman & Hansen 1988:32). The colour varies from light red to dark reddish-brown and can even be black in old animals. It is attached by ligaments to the anterior abdominal wall and to the stomach by the lesser omentum. The liver is separated from the pluck by cutting through the attachment to the diaphragm. The texture and flavour of liver is affected by species and animal age, with livers from young animals being lighter in colour, with a more delicate flavour and more tender than those from elder animals. Liver from mutton, older bulls and cows are usually used in manufactured or processed meats (MaCrae *et al.* 1993:3343).

3.1.2 Spleen

The spleen is a specially-designed lymphatic organ, with an elongated oval shape, contained in the abdomen and attached to the rumen, but it is considered not to be part of the digestive system (Ockerman & Hansen, 1988:54). The spleen may be fried, used in pies and/or in blood sausages. It is dark in colour and has poor binding ability with a high collagen content, which gives sausages a gristle-like texture. According to Oliveros *et al.,* (1982:7), beef spleen, lung and kidneys were found to have a high sarcoplasmic proteins contents than other by-product such as beef heart, tongue and oesophagus except that of liver. Beef spleen was also found to have the lowest percentage free water (water holding capacity), high myoglobin content except that of liver and least emulsion stability. Oliveros *et al.,* (1982:13-17).

3.1.3 Heart

Beef hearts are conical in shape and average approximately 1.4 kg (normal range 1.4-2.0 kg) (Ockerman & Hansen, 1988:41). Whole hearts are removed from the pericardium and separated from the lungs and remainder of the pluck by cutting the aorta and pulmonary vein. Hearts are sometimes slashed open after slaughter for inspection and clotted blood, cartilages and some of the fatty tissues removed. They are found to be less tender than liver, are merchandized fresh or frozen and used in processed luncheon meats (emulsions). In these products they are not only a source of high quality protein but also add colour to the finished product due to high myoglobin content. They have a low-to-medium binding value and are of average collagen content (Ockerman & Hansen, 1988: 41). According to Ockerman & Hansen, (1988: 44), the water:protein average ratio of beef heart was found to be 4.4:1.

3.1.4 Lungs

According to Spooncer (1988:201), the tissues of the lungs consist of the epithelial lining of the alveoli and the endothelial lining of the capillaries which surrounds the alveoli, each supported by the basement membrane. Lungs can also be used during the making of sausages and manufactured meat or be braised either whole or cubed. The capillaries and alveoli are very close to each other with a small amount of connective tissue between them (Spooncer, 1988:201).

3.2 Rough offal

“Rough offal” means the stomach, intestines, feet and skin on the head of the slaughtered animal except in the case of pigs where the head and feet are part of the carcass (Department of Agriculture, 2004:3). “Rough” offal requires careful cleaning and preparation to remove stomach and intestinal contents before it can be used as an edible product. Cleaning of the intestinal offal usually takes place at a separate area from other (red) offal and carcass meat to prevent cross-contamination.

3.2.1 Bovine stomachs

Bovine stomachs are divided into four compartments that can all be used to make “tripe”. The true stomach in the ruminant is called the abomasum. It is the first glandular region of the ruminant digestive system (Frandson, 1981:253) preceded by three divisions, called the rumen, reticulum and omasum. The three divisions are collectively known as the forestomachs. The anatomy of the bovine stomach, A) view from left B) view from right, C) internal anatomy of the whole ruminoreticulum is illustrated in Annexure 1.

3.2.2 Abomasum

The abomasum is located beneath the omasum on the right side of the rumen and according to Frandson (1981:257), the epithelium of the abomasum changes suddenly from the stratified squamous epithelium of the omasum to a tall simple columnar epithelium, which has the ability to produce mucus. The mucus covering the stomach epithelium prevents the digestive juices from digesting the stomach cells themselves (Frandson 1981:257).

3.2.3 Rumen and reticulum

According to Spooncer (1988:202), tripe (cut pieces of rumen and reticulum) is derived from the rumen (pouch) and reticulum, the most widely used parts of the ruminant stomachs. The rumen tripe is known as the “blanket tripe” in Australia, with densely packed papillae. The reticulum is also called the honeycomb. According to Frandson (1981:253), the reticulum is lined with a mucous membrane containing many intersecting ridges that divide the surface into honeycomb-like compartments due to these ridges. Its surface is covered with a stratified squamous epithelium. The reticulum is positioned behind the diaphragm, placing it almost opposite to the heart, therefore if foreign objects such as nails or wire are swallowed, they tend to lodge in the reticulum. This means they are in a very good position to penetrate the heart (Frandson 1981:253).

3.2.4 Omasum

The third compartment of the ruminant stomach is known as the omasum. The omasum has deep, thin folds like book pages making it popularly referred

to as the “bible”. It is located at the right of the rumen and reticulum, behind the liver and is filled with muscular laminae (Frandson, 1981:257). The mucous membrane covering the laminae, is studded with short, blunt papillae, which grind roughage before it enters the abomasum (true stomach) (Frandson, 1981:257). Due to its high connective tissue content, tripe is tough, requiring a prolonged, moist cooking method to soften it.

3.2.5 Intestines

Pork and beef intestines are collected directly after slaughtering and dressing the carcass and are immediately and thoroughly cleaned. The intestines of the digestive tract of cattle, pigs and/or sheep are used as sausage casings during the making of sausages (Ockerman & Hansen, 1988:52)

3.3 Nutritional values of beef offal parts

In a research conducted by Oliveros *et al.,* (1982:7), beef spleen and liver were found to contain a significantly higher protein content than other by-products such as beef lung, tripe, hearts, abomasums, small and large intestines. Liver and spleen were found to be similar to lean beef in proximate composition Oliveros *et al.,* (1982:7). According to Magoro 2007:78, raw beef offal parts are good sources of protein, phosphorus, iron and selenium when compared to beef shoulder see highlighted rows (Table 1) below.

4. MEAT SAUSAGES

Sausage can be defined as a food that is prepared from comminuted and seasoned meat usually formed into a symmetrical shape (Wilson, 1960:349).
It is derived from the Latin word *salsus*, which means salted or, literally, meat preserved by salting (Kramlich, 1960:484). Feiner (2006:297) reported that **Fresh meat sausages** are meat products sold fresh without priorheattreatment. Ranken (2000:131) defined fresh meat sausages as uncured, uncooked meat products with various degrees of comminution, various levels of meat content, a short shelf-life and a coarse texture.

TABLE 1. Nutrient density of raw beef offal parts and A-age (11.45% fat) beef shoulder (for females aged 31-50 years)

Nutrients	Nutrient density						
	Beef heart	Beef intestines	Beef liver	Beef lungs	Beef spleen	Beef stomachs	*Beef shoulder
Protein	4.06	1.83	8.14	8.99	8.17	4.11	6.14
Minerals							
Calcium	0.27	0.2	0.4	0.55	0.43	0.53	0.08
Phosphorus	2.81	1.21	8.53	3.63	7.25	1.76	2.89
Potassium	0.57	0.17	1.07	0.68	1.44	0.26	0.77
Sodium	0.77	0.24	0.94	2.36	1.14	0.45	0.73
Iron	5.87	2.81	5.27	17.57	25.16	5.89	0.47
Selenium	6.16	3.49	21.6	15.96	17.85	6.18	NA

*Nutrient Density ≥1.00 indicates a good source of the specific nutrient,

Coloured in areas values are greater than 1

*Schönfeldt and Welgemoed, (1996:18)

NA – Not analyzed for

Emulsion sausages are made from finely comminuted lean meat and fat (Ranken, 2000:131). This type of sausages are often further processed by adding curing salts, drying, smoking and cooking. Meat sausages, both fresh and emulsions, are found to be economical as they are commonly manufactured from cheaper cuts of meat and by-products. According to Ranken (2000:130), the primary economic purpose of sausages was originally, and still is, to present relatively large proportions of fat in palatable ways. Sausage products take little time to prepare with some being ready-to-serve or simply warmed before serving. For these reasons sausage is favoured by both working men and women.

4.1 Nutrient content of sausages

Apart from being economical, sausages are acceptable to consumers today because they are convenient, have good variety and nutritional value and contain important amounts of high quality protein. According to Lushbough & Schweigert (1960), the nutritional quality of a food protein is determined by the relative proportions of the essential amino acids it contains. Both plant

and animal proteins are made up of about 20 common amino acids; however, only nine amino acids - histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine - are essential in human diets (Henley & Kuster, 1992). Sausages are also good sources of various essential minerals such as iron, zinc, folic acid, vitamins B_6 and B_{12} and fat for energy (Pearson & Tauber, 1984:188).

During the development of the raw control and meat sausages containing beef offal (formulations 1 to 4), meat sausages were found to be good sources of protein, vitamins B_3 (Niacin), B_6 (Pyridoxine) and B_{12} (cyanocobalamin) and minerals (magnesium, phosphorus, iron and selenium). A high vitamin B_{12} content was observed in all four sausages (see highlighted values on Table 2 below) (Magoro 2007:80). Proximate chemical analyses results on Table 1 and 2 were previously analysed only in duplicate by the ARC-Irene Analytical Services Laboratory due to financial constraits.

TABLE 2. Nutrient density values for the protein, vitamin and mineral contents of the raw control and four formulations containing beef offal, for females aged 31-50 years

	Nutrient density*				
Nutrients	(Control) (B, R)	**1** (B, IN, S, H & R)	**2** (B, IN, S, H & MB)	**3** (B, Lu, ST, Li, & R)	**4** (B, Lu, ST,Li & MB)
Protein	3.70	5.68	4.60	4.47	5.15
Niacin	2.86	3.47	3.18	3.05	4.32
Pyridoxine	2.73	3.51	3.94	4.20	6.34
Cyanocobalamin	7.44	30.01	18.92	64.04	73.63
Magnesium	1.08	1.36	1.44	1.28	1.31
Phosphorus	2.28	3.70	3.51	3.40	3.96
Sodium	5.40	6.71	6.13	6.07	6.87
Iron	1.80	5.18	3.73	2.90	4.12
Selenium	10.06	10.44	6.88	6.69	8.52

*Nutrient Density ≥1.00 indicates a good source of the specific nutrient, C= Control, B=Beef trimmings, IN=Intestines, S= Spleen, H= Heart, R= Rusk, Li= Liver, ST= Stomachs, L= Lung and MB= Multibase™

5. MICROBIAL SPOILAGE OF EDIBLE BY-PRODUCTS

The gastrointestinal tract of normal herbivorous animals harbours numerous organisms of a large range of genera and species (Horton & van der Heever, 1972:251). These organisms cause spoilage or are potentially pathogenic and may even be able to cause food poisoning (Horton & van der Heever, 1972:252). Patterson & Gibbs (1979:209) stated that edible offal is relatively perishable with a shelf-life at chiller temperatures (0-4 °C) of only two to three days. Edible by-products can generally be expected to present a rich source of nutrients for microbial growth (Gill, 1988:52).

Food-poisoning and gastro-enteritis-causing bacteria which are animal and animal intestinal tract-associated, belong to the genera *Staphylococcus, Salmonella, Clostridium* and *Campylobacter.* These organisms are capable of growth on meat and meat by-products (Gill, 1988:54). According to Nottingham (1982:13-66) meat by-products are collected in bulk soon after their removal from the carcass. Trimmings and meat by-products also undergo extensive handling and are likely to become contaminated with staphylococci (Nottingham, 1982:13-66). Comminuted meat, such as minced beef and sausages, are found to contain higher numbers of microorganisms than non-comminuted meats such as steaks, because commercially minced meat generally consists of trimmings from various cuts that are handled excessively and minced or ground meat that are produced from large cuts tend to have lower microbial number (Jay, *et al.,* 2005:67).

According to Gill (1988:58), livers obtained soon after removal from carcasses carry both internal and external flora. External flora are dominated by the gram-positive mesophiles, such as micrococci at a level of 10^3 and $10^5/cm^2$ and internal contaminants at levels of about $10^2/g$. The internal flora comes from bacteria migrating into the open sinusoidal structure after the organ has been removed from the carcass. Storage of livers at chiller temperatures in polythene bags results in lactobacilli and or facultative anaerobic species forming significant portions of the microbial population (Gardner, 1971: 225). Patterson & Gibbs (1979:209) indicated that the spoilage flora development

on hearts held at chiller temperatures is similar to that observed for liver. The warm bulk packs of organ by-products such as liver, hearts and kidneys provide an excellent medium for rapid *E. coli* proliferation at ambient temperatures (Gill and Harrison, 1985:63).

5.1 Microbiological Spoilage of Meat sausages

According to Jay (2000:61) the numbers and types of microorganisms present in finished food products are influenced by the following factors, namely:

(i) the general environment from which the food was obtained;

(ii) (ii) the microbiological quality of the food in its raw or unprocessed state;

(iii) (iii) the sanitary conditions under which the product is handled and processed and

(iv) (iv) the subsequent packaging, handling and storage. In order to produce quality food products, it is important to maintain a low level of microorganisms for aesthetic, health and product shelf-life reasons (Jay, 2000:61).

Sausages and frankfurters, in addition to their meat components, have additional sources of organisms in the seasonings and other formulation ingredients/additives such as spices that are added during production (Jay, 2000:72). In the case of pork sausages, natural casings (salt-packed) were found to contain numbers of bacterial counts ranging from log 4.48 to 7.77 and from log 5.6 to 7.36 for wet-packed casings (without salt) (Riha & Solberg, 1970:860-863). Rusk, which is a specially prepared material made from wheat flour used during the development of fresh meat sausages (Ranken, 2000:137) was found to contain a maximum of $1x10^6$ cfu/g total aerobic plate counts when analysed (Personal communication, Christians: 2007). According to (Magoro, 2007:129) the microbial quality of the raw materials and raw fresh meat sausages containing beef offal were found to be comparable to that of the control beef fresh sausage and raw materials used. Therefore it is imperative that all formulation ingredients and raw material be analysed or, if purchased, should have a microbiological certificate to ensure

that microbiologically, they conform to the maximum microbiological standards for foodstuffs and related matters specified by the Department of Health (Department of Health,1997:16) . This will assist in developing good quality end-products.

6. SENSORY EVALUATION

The conducting of sensory evaluation, according to Meilgaard *et al.* (1991:2), has been done ever since human beings started evaluating the acceptability of food, water and everything else that can be consumed. Jellinek (1985:17) stated that sensory analysis of food depends on evaluation through the use of our senses (odour, taste, hearing, tactile, temperature and pain). Stone and Sidel (1993:12) refer to the 1975 IFT definition of sensory evaluation as ”a scientific discipline used to evoke, measure, analyze and interpret reactions to those characteristics of foods and materials as they are perceived by the senses of sight, smell, taste, touch and hearing.” The sensory evaluation classification methods can be seen in Table 3. In the current pilot study on the development of fortified offal sausages and polonies, a descriptive and hedonic verbal scale methods will be used.

Human subjects are trained and used as the measuring instruments to evaluate the sensory properties of a product Jellinek (1985:24) stated that human subjects must have normal olfactory and gustatory sensitivity that can be improved during training. Although human subjects are found to be variable over time, variability among them is prone to bias. It is therefore important to minimize variability by recruiting enough subjects (20 – 50 in consumer panels at least) so that verdicts are representative (Meilgaard *et al.* 1991:8). The sensory attributes of taste, texture, tenderness and colour of sausages relate directly to the ratio of fat-to-lean meat used during sausage processing (Pearson & Tauber 1984:190). The inclusion of the red offal parts such as beef heart, spleen, lungs and liver in sausage formulations was found to have a great influence on the finished products colour (Magoro,2007. The colour of the end-products will be evaluated by the trained panel and Hunter L*, a* and b* colour measurement system. Kramlich (1960:493-494) stated

that the different animal tissues differ in moisture:protein ratios, fat:lean ratios and binding properties. Lean skeletal tissue(s) from cattle, pigs, sheep and lean pork trimmings are considered to have high binding properties (Kramlich, 1960:493).

Younger and older people may be used as test subjects. Younger persons may have more taste buds, whereas older persons can concentrate better thereby balancing the results (Jellinek, 1985:24). People who are ill, for example suffering from colds or flu, should not participate during testing.

According to Pearson & Tauber (1984:190) the sensory attributes of taste, texture, tenderness and colour of sausages relate directly to the ratio of fat-to-lean meat used during sausage processing Kramlich (1960:493-494) stated that the different animal tissues differ in moisture:protein ratios, fat:lean ratios and binding properties. Lean skeletal tissue(s) from cattle, pigs, sheep and lean pork trimmings are considered to have high binding properties (Kramlich, 1960:493). Kramlich (1960:494) further stated that head and cheek meat are of medium value as binders.

Meats with inferior binding properties (poor binders), usually contain a large proportion of fat or non-skeletal or smooth muscle (Wilson, 960:353). Hearts and cheek meat are a good source of myoglobin and therefore, according to Wilson (1960:354), hearts and cheek meat can be used in the products containing pork that are inclined to be pale in colour (Wilson, 1960:354). According to a research conducted by Magoro (2007:186-189), the control formulation which contained 60% of beef trimmings, rusk and a standard mixture of spices and formulation 2 (which contained 26 % beef trimmings, 10 % intestines,15 % heart, 9 % spleen, Multibase™ and a standard mixture of spices) were most acceptable in terms of desirable sensory attributes/properties such as aroma, flavor and texture attributes as judged by the consumer panel and “appearance of juiciness” and “aroma intensity” as judged by the trained panel.

TABLE 3. Classification of sensory evaluation methods and panels

Classification of methods by functions		
1 Analytical tests: (trained judges) Evaluate differences or similarity, quality and/or quantity of sensory characteristics of a product. 1.1 DISCRIMINATIVE TESTS 1.1.1 Difference tests: Measures simply whether samples are different 1.1.2 Sensitivity tests: Measures ability of individuals to detect sensory characteristics **1.2 DESCRIPTIVE TESTS: Measures qualitative and/or quantitative characteristics** (Scales = use of numbers to indicate the degree/amount/strength of attributes/characteristics)	**Appropriate methods** 1.1.1.1 Paired-comparison 1.1.1.2 Duo-trio 1.1.1.3 Triangle 1.1.1.4 Ranking 1.1.1.5 Rating difference/scalar difference from control 1.1.1.6 Threshold 1.1.1.7 Dilution 1.2.1 Attribute rating 1.2.1.1 **Category scaling verbal** and linear (structured/unstructured) 1.2.1.2 Ratio scaling (magnitude estimation) 1.2.2 Descriptive analysis 1.2.2.1 Flavour profile 1.2.2.2 Texture profile 1.2.2.3 Quantitative description analysis	**Type and number of panellists** 1. Screened for interest, ability to discriminate differences and reproduce results 2. Trained to function as a human analytical instrument 3. Normal sensory acuity 4. Periodic requalification 5. Panel size depends on product variability and judgement reproducibility 6. No recommended “magic number” – a number often used is 10; a recommended minimum number is generally 5, since fewer could represent too much dependence upon one individual’s responses.
2 **AFFECTIVE TESTS** (untrained judges, **consumers)**: **Evaluates preferences and/or acceptance and/or opinions of the product** (Often evaluates the overall character of the food)	2.1 Paired-preference 2.2 Ranking 2.3 Rating 2.3.1 **Hedonic rating scale (verbal** or facial) 2.3.2 Food action rating scale	1. Randomly selected 2. Untrained 3. Representative of target population 4. Consumers of test product 5. No recommended “magic number” – minimum is generally 24 panellists, which is sometimes considered rough product screening: 50-1000 panellists usually considered adequate.

SED, IFT, (1981b:35)

Formulation 2 was found to be most acceptable in the South African context, other formulations contained 26 % beef trimmings, 15 % beef heart, 10 % stomachs, 9 % lungs and either rusk or Multibase™ and a standard mixture of spices.

7. CURRENT RESEARCH PILOT STUDY

The current pilot study includes the development of fortified fresh meat sausages and emulsion–type products (polonies) utilizing alternative protein sources such as culturally-acceptable red beef offal (beef hearts, lungs, spleen and liver),based upon Magoro 2007's M.Tech. study's results. The trial batches with the control were developed and analysed for proximate chemical analyses at the ARC-Irene Analytical Services. Only single proximate chemical analysis values were obtained, due to insufficient funding. The consumer and trained panel sensory evaluations still need to be conducted, for fortified sausages and emulsion type products (Ready-to-Eat or RTE-polonies), but current funding does not allow this.

Amino acids profile, fatty acid profile, Vitamins B_1, B_3, B_6 and B_{12}, minerals and heavy metals should be determined to evaluate the 'natural fortification' of these products since liver and spleen were used in the formulations. Funding is therefore requested, to complete the final stage of this research which focuses on the use of red beef offal parts and consequently the future expansion of this project could include other readily-available species such as goat and sheep offal. Table 4 below shows the methods that will be used to determine the nutrient content of fortified sausages and emulsion products.

Analysis will be done at ARC-IRENE Analytical services Laboratory. This proposed project involves more fully utilizing waste meat (abattoir) processing products to apply value-addition principles to certain meat products, such as raw sausages (which are easily cooked) and emulsion-type products, such as polonies (which are RTE). This technology could easily be further developed into wide enterprise creation, including processing, brand development and marketing of the resultant products.

TABLE 4. Summary of methods used for nutrient analyses

Analysis	Method	Accredited Number	Reference
Protein (N)	Dumas combustion method	ASM 048	Official method 992.15 AOAC (2005)
Fat	Soxtec ether extraction	ASM 044	Official method 960.39 AOAC (2005)
Moisture (Water)	Gravimetric	ASM 013	Official method 920.153 AOAC (2005)
Ash	Gravimetric	ASM 048	Official Method 920.153 AOAC (2005)
Energy	Calculated	ASM 076	(Atwater & Bryant, 1900)
Water-soluble vitamins:	**All analysed using**:	**All analysed using:**	
B_1 & B_2	High performance Liquid Chromatography (HPLC)	ASM 025/071	Fellman *et al*. (1992)
B_3		**SABS	Official Method 961.14 AOAC (2005)
B_6		**SABS	Official Method ALASA 7.2.3
B_{12}		**SABS	Official Method 986.23 AOAC (2005)
Ca, P, K, Na, Mg, Fe	ICP-OES	*ARC-ISCW	Zasoski & Burau (1977:425-436)
Pb, Cd, Hg and Se	ICP-OES	*ARC-ISCW	Zasoski & Burau (1977:425-436)
Amino acids	High performance Liquid Chromatography (HPLC)	ASM 021	Einarsson *et al.* (1983:609-618
Fatty acid profile(including CLA)	Gas Chromatography (GC)	ASM 023	(Christopherson & Glass, 1969)
Cholesterol	Gas Chromatography (GC)	ASM 056	Smuts *et al*. (1992)

The objectives of the current research study include:

1. To complete current formulations of culturally-acceptable fortified fresh sausages and polonies, using red beef offal parts (liver, heart, spleen, lungs), beef trimmings, ISP (Isolate Soya Protein), standard spice mix and rusk.
2. To determine the functional characteristics of the red beef offal parts and ingredients such as beef liver, heart, spleen, lungs, ISP, TVP (Texturised vegetable protein), Pork rinds, MDM (mechanically deboned meat), phosphates, and starches and standard spice mix to be used during the processing of fresh and emulsion sausages.

3. To link the research results obtained from the Nutrient composition of offal project/study which will be conducted by Dr Ina van Heerden to this project.
4. To obtain funding to determine the nutritional value of the best (ten) products (sausages and polonies), their chemical composition, microbiological quality, shelf-life, sensory quality attributes and consumer acceptability

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ANNEXURE 1.

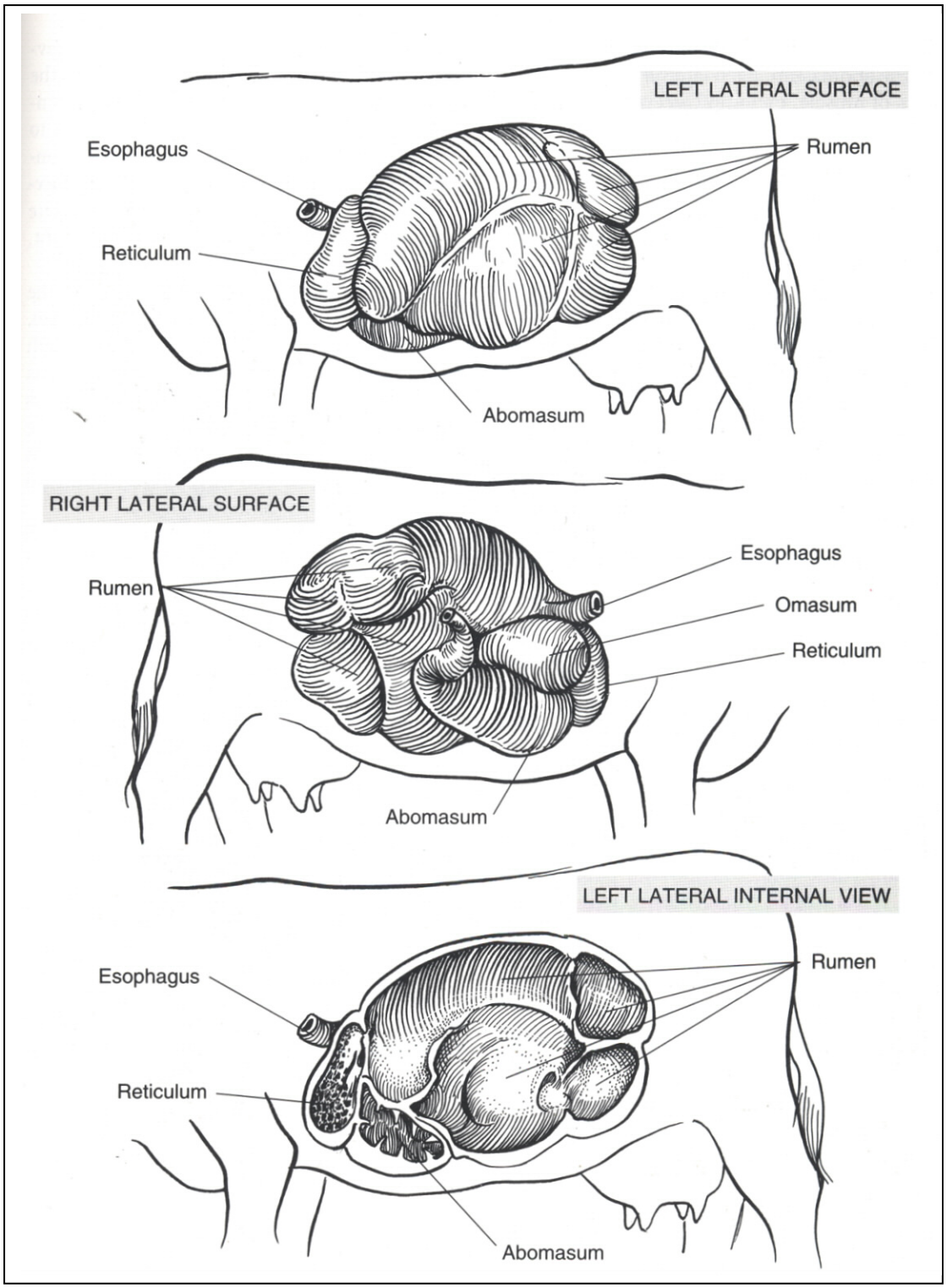

Illustration of Bovine stomachs