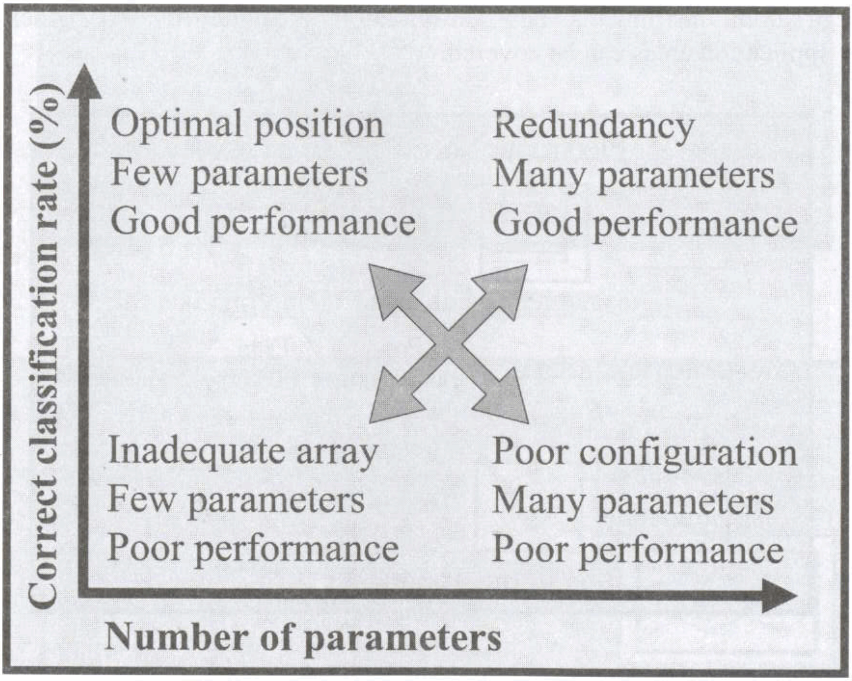
8.0 DATA FUSION

8.1 DATA FUSION METHOD

- **Low level abstraction**
  - **Combining all sensor data to form a single data matrix**
- **High-level abstraction**
  - **Combining important features from all the sensor system**



- **Data fusion based on**
- **Important features/ parameter**
- **Minimum number of sensors**
- **Maximum performance**

8.2 COMBINED ENose AND ETongue

The sensor data fusion process is defined in a method which gathers observations from two single artificial perceptions, the smell and taste, combines them into a single, coherent percept (opinion). Fusing the data of an ENose and an ETongue can result in a highly increased performance. Due to a high complexity of food/herbals samples the use of just tongue or nose data in some application can be insufficient. Therefore data fusion together with signal processing pattern classification algorithms seems to be the right choice in order to increase the performance of the system. Combining the properties of both instruments new information is obtained and wider application areas can be covered.

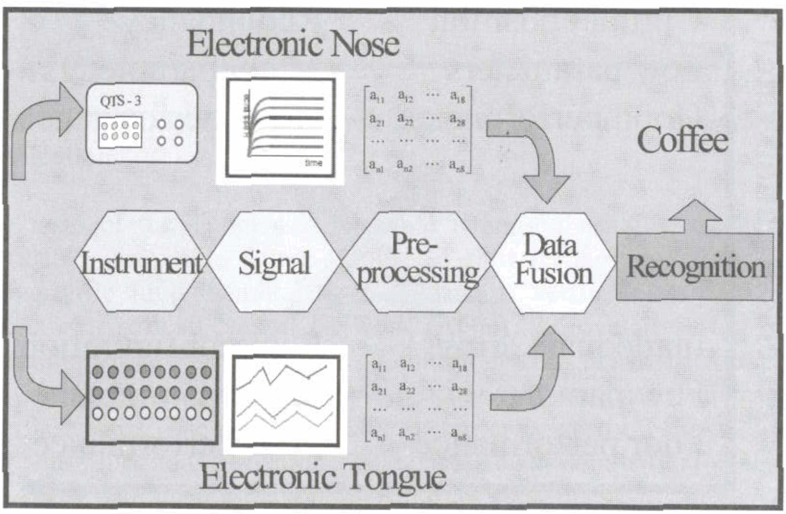


Figure 8(a): Novel data fusion technique

Figure 8(b): Taste and Smell Sensor

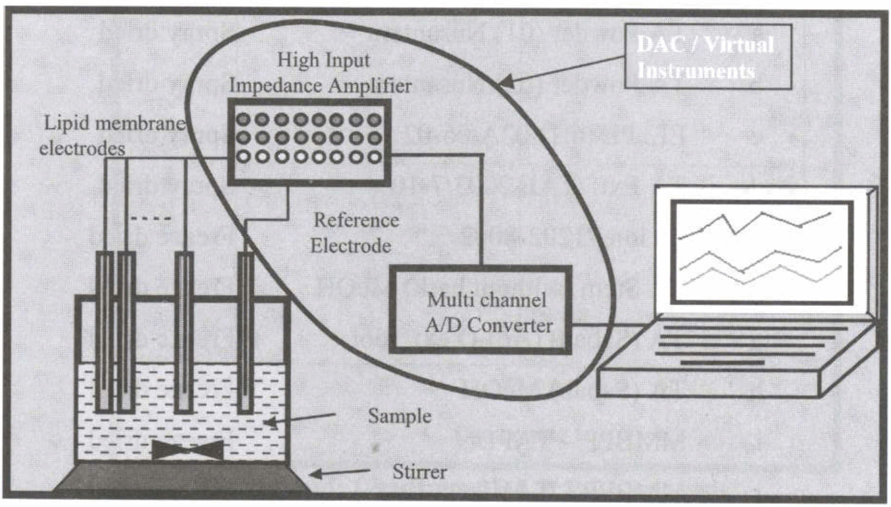


Figure 8(c): Experimental Set-up of Taste Sensor

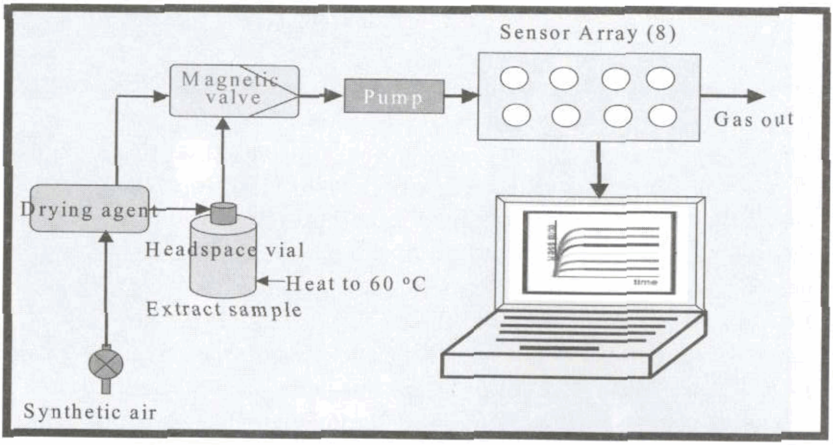


Figure 8(d): Experimental set-up of Smell Sensor

Table 1: *Eurycoma longifolia* extracts analyzed for the data fusion of Taste and Smell sensors

	Sample	Drying method
a	TA Powder (01) Nusantara	Spray dried
b	TA Powder (02) Nusantara	Spray dried
c	EL. PE (6:1) 02A/06-02	Spray dried
d	TA Ext. /TAE 2003/7-10	Spray dried
e	Eu long/1202-8002	Freeze dried
f	TA Stem (without bark) MeOH	Freeze dried
g	TA (Sabah) $(Ac)_2O$ ext. root	Freeze dried
h	TA (Sabah) MeOH	Freeze dried
i	MMBPP – TAFD	Freeze dried
j	MMBPP – TAET	Freeze dried

8.2.1 TASTE SENSOR

The eigenvalues of **Data fusion of Taste and Smell sensors**

The samples used for the data fusion of Taste and Smell sensors are shown in the Table 1.

PC1, PC2, PC3 and PC4 are 50.47%, 28.00%, 10.99% and 7.65% respectively. Total 97.42% of the total information was acquired by the first four principal components. Sensor 1, 2, 4, 7 and 8 has high loading to PC1 and sensor 3, 5, 6 and 7 has high loading to PC2. From the loading plot, sensor 1, 2, 4 and 8 are very close to each other and they are redundant. They have similar contribution to PC1. From the Taste sensor group, sensor 3, 4, 5, 6 and 7 could be consider as best array sensor for Taste analysis of *Eurycoma longifolia* extracts. The PCA analysis of Taste using 3, 4, 5, 6 and 7 sensors are shown in Figure 8(e). In both case sample e are not nicely classified.

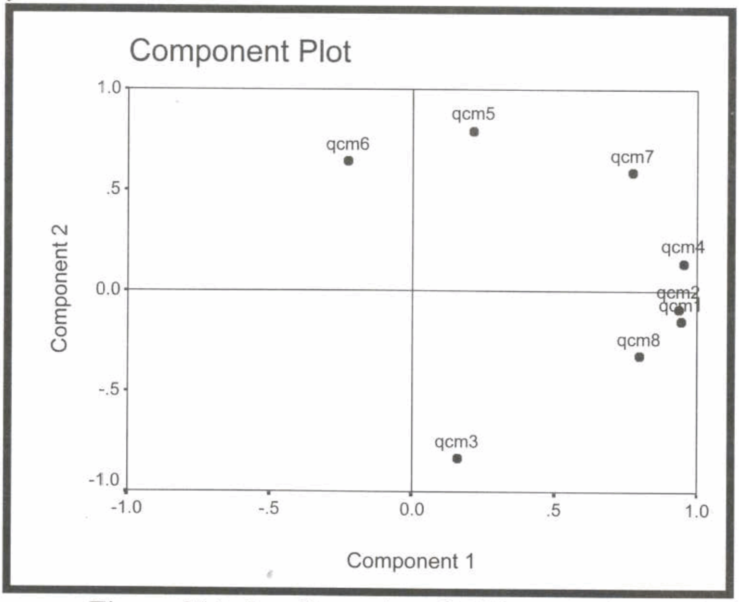


Figure 8(e): Loadings plot of PCA analysis

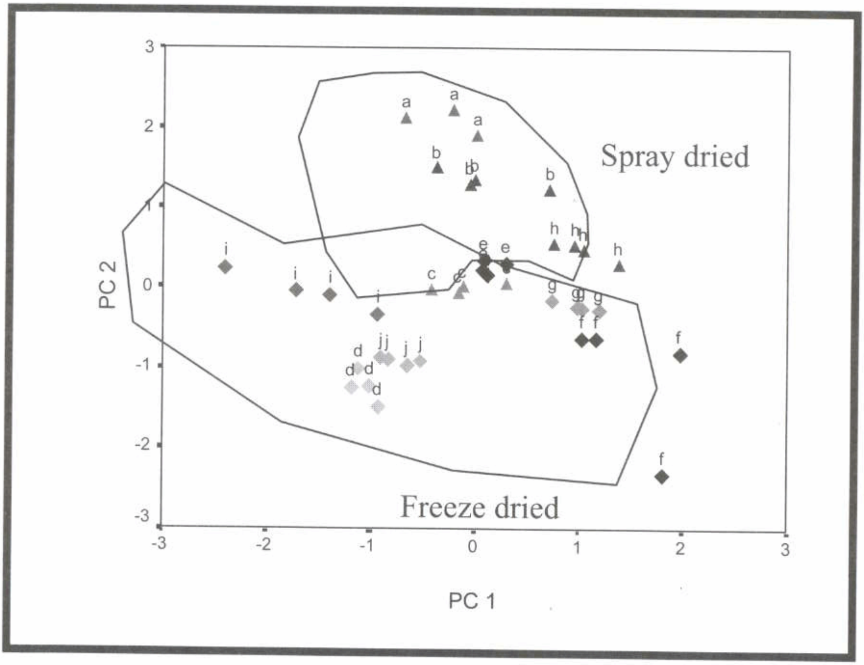


Figure 8(f): Scores plot of PCA analysis

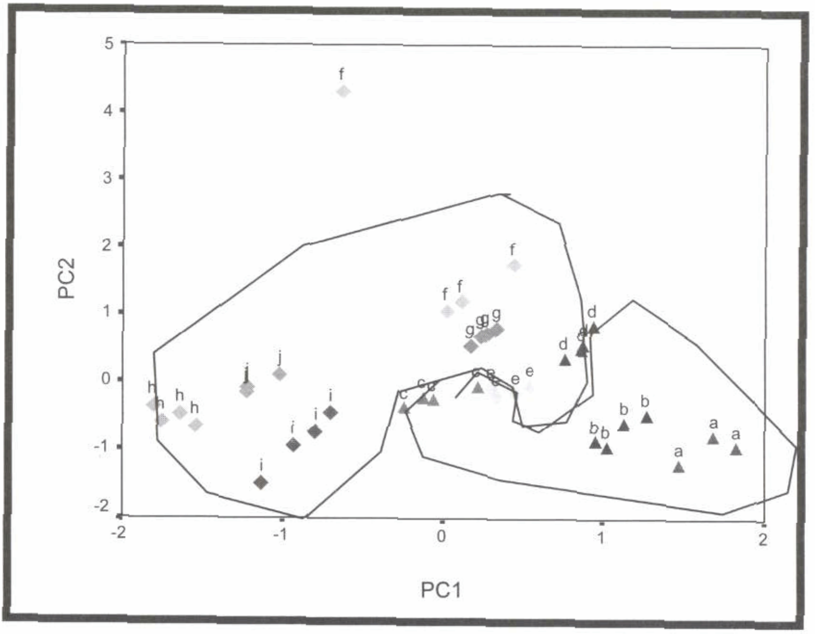


Figure 8(g): PCA analysis of sensor 3, 4, 5, 6 and 7

8.2.2 SMELL SENSORS

The classification of *Eurycoma longifolia* extracts using smell sensor is shown in Figure 8(h). Sensor 2, 3, 4, 5 and 7 has high loading to PC1. These sensors are redundant. On the other hand, sensor 1 has high loading and sensor 6 and 8 has moderate loading to PC2. Sensor 1, 4, 6 and 8 is considering good array sensor for E. *longifolia* extracts.

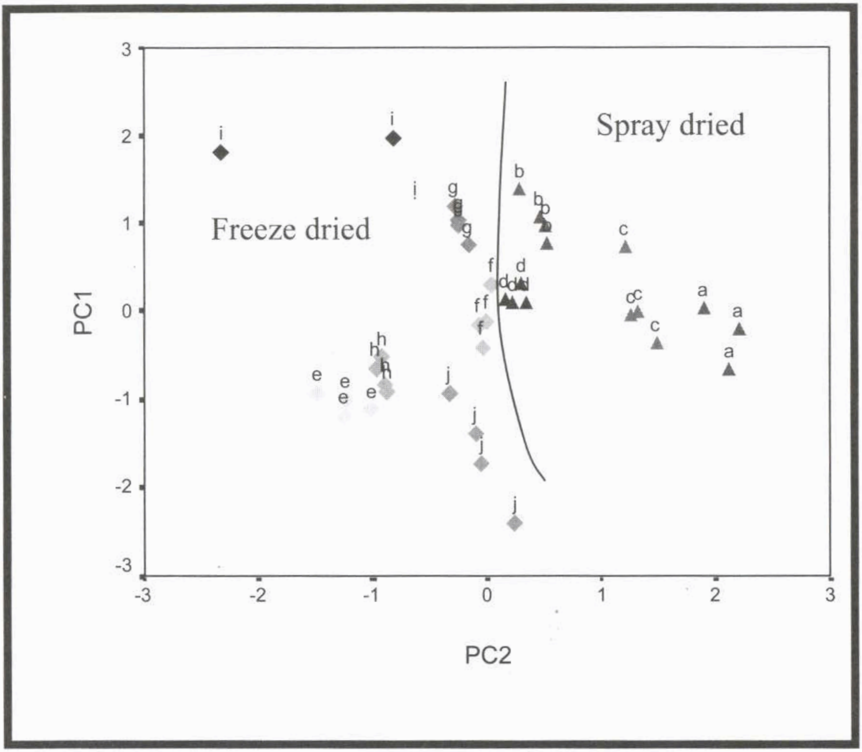


Figure 8(h): Scores plot of the PCA analysis of the Smell sensor

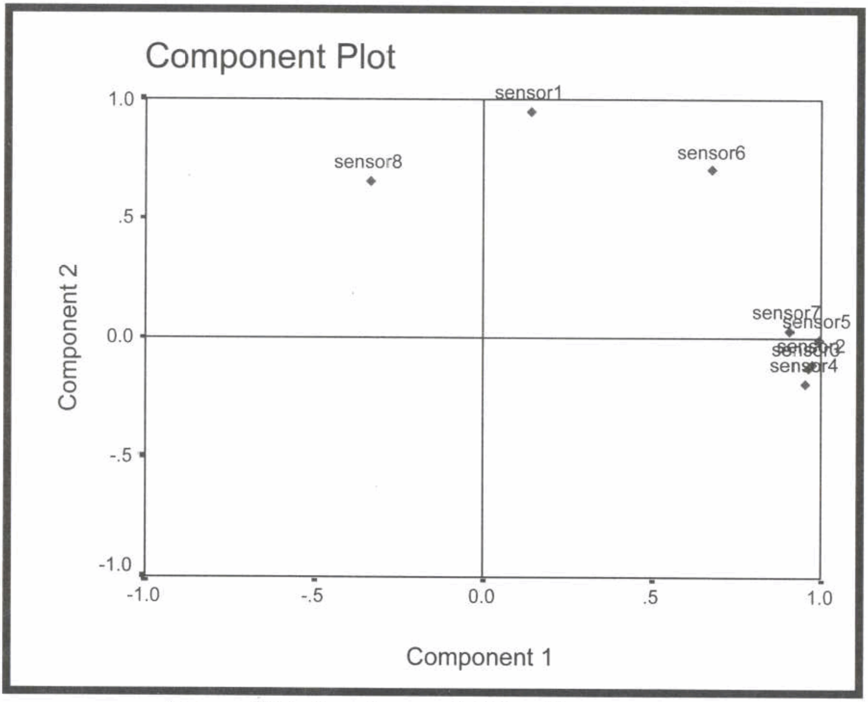


Figure 8(i): Loadings plot Smell sensors

8.2.3 DATA FUSION

The data fusion of Taste sensor 3, 4, 5, 6 and 7 and Smell sensor are shown in Figure 8(j). In this case 64.28% and 27.52% (total 91.80%) variances were extracted by PC1 and PC2 respectively. In this case all the samples were nicely classified.

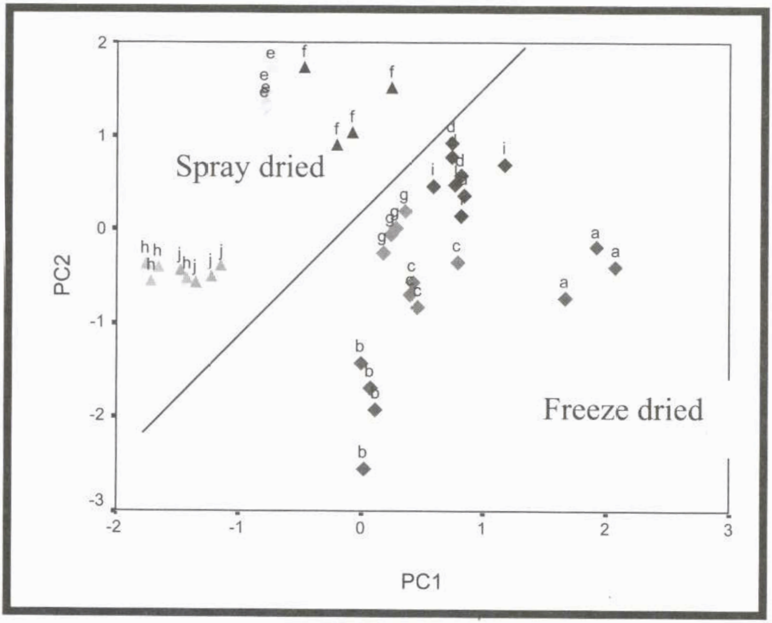


Figure 8(j): Data fusion of Taste and Smell sensor